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ART. X.—*Some New Discoveries respecting the Dates on the great Calendar Stone of the Ancient Mexicans, with Observations on the Mexican Cycle of Fifty-two Years;* by E. G. SQUIER, New York.

THE most interesting monument of antiquity which has been discovered in America, is unquestionably the great Calendar Stone of the Aztecs, which now occupies a place in the walls of the Cathedral of the city of Mexico. It is an immense mass of porphyry, estimated to have weighed originally upwards of thirty tons. Its horizontal face is inscribed with a circle in relief, within which is found a complication of signs and figures, chiefly of an astronomical character, and referring to the motions of the sun. The relative positions and dependencies of these signs cannot be indicated without the aid of an engraving. I shall therefore, without going into a particular account of the stone,—involving, as it necessarily would, a complete analysis of the Aztec Calendar,—simply call attention to some of the results which have attended its study by Gama, Humboldt, Gallatin and others, so as to be able to submit, in a comprehensible manner, some additional discoveries which have followed its investigation, under more favorable circumstances.

The authorities above named, ascertained the existence of five signs upon this stone, referring to the principal annual positions of the sun, viz: the dates of the two transits of the sun by the zenith of Mexico, the dates of the vernal and autumnal equinoxes, and the date of the summer solstice. The summer solstice, according to the stone, occurred on the 22d of June; the

transits on the 22d of May and the 26th of July, and the equinoxes on the 22d of March and the 22d of September. This arrangement, it will be seen, gives 184 days from the vernal to the autumnal, and 181 from the autumnal to the vernal equinox, which, as observed by Mr. Gallatin, "although not strictly correct, shows that the Aztecs had ascertained by observation that the Sun remained longer North than South of the Equator, which is true, since its apparent motion is not uniform, but is accelerated during the time it appears south of the equator."* The transits of the sun, by the zenith of Mexico, were calculated by Gama and found to coincide with the dates engraved on the stone,—demonstrating that the observations which led to the original discovery of the true date were made in Mexico, and indicating that the astronomical knowledge of the Mexicans was of American origin.

These authorities also, from analogy and a consideration of a variety of circumstances which it is unnecessary to recapitulate, arrived at the conclusion that "the winter solstice corresponded with our 22d of December or very near it." None of them were however, able to detect the date of this solstice upon the stone. The supposed deficiency was accounted for, hypothetically, upon the assumption that the dates on the Calendar were calculated only for half of the year, viz: from the vernal to the autumnal equinox. There is nothing however, on which to ground this assumption, but the very deficiency, for which it was intended to account.

The difficulty, in the way of the satisfactory elucidation of the matter, has been the imperfect character of the engraved copy of the stone upon which the investigations of these scholars were founded. Until recently there has been but one drawing in existence, viz: the one which accompanies Gama's work upon the Mexican Calendar. This was reproduced by Humboldt in his "Researches," and is the same which was consulted by himself and Mr. Gallatin in their enquiries. Within a few years, a larger and very beautiful drawing has been made from the original, by M. Nebel, which is inserted in his splendid work on Mexico. This drawing, while it attests the general accuracy of that published by Gama, has enabled me to detect a most important error in the latter, and to clear up the doubt which has heretofore existed as to the date assigned by the Aztecs to the winter solstice.

The central figure upon the Calendar Stone is a symbolical representation of the sun, with protruding tongue, indicating life,—*to talk* among the Aztecs conveying the same idea of

* "Notes on the semi-civilized Nations of America," Trans. Am. Ethnological Society, vol. i, p. 101; Humboldt's Researches, vol. i, p. 293.

vitality with *to breathe* in our own language, and *to eat* and *to walk*, in those of different stocks. The forehead of this figure is bound with a fillet, upon which, in Gama's drawing, is represented a group of unmeaning ornaments. In place of these, we have, in M. Nebel's copy, the distinct sign of 2 *Acatl*. Above it is an indicating ray, which points to the sign of the year 13 *Acatl*, for which year most of the engraved calculations seem to have been made. The day 2 *Acatl* for year 13 *Acatl*, (which is the 26th of the Aztec cycle,) *coincides with our 21st of December*, and is undoubtedly the hitherto undetermined date of the winter solstice, in the Mexican Calendar.

Fig. 1.

Fig. 2.

Fig. 1, of the accompanying engraving of the sign in question, is from Gama's drawing; Fig. 2, from Nebel's. *Acatl* signifies *a reed*. The central figure, of the second engraving, is a very common form of this sign, both in the paintings and on the monuments. It will be at once seen that the figures presented by Gama could not by any possibility be supposed to represent 2 *Acatl*, and hence the deficiency remarked by the illustrious investigators above named.

This discovery verifies the correctness of Gama's Analysis of the Aztec Calendar, at the same time that it furnishes us with an explication of certain religious observances, of a very remarkable character, prescribed, at fixed intervals, by the Aztec ritual.

The civil year of the ancient Mexicans was a solar year of three hundred and sixty days made up of eighteen months of twenty days each. To these were yearly added five complementary days, called *Nemontemi* or "*dead days*," which were deemed unlucky, and during which all religious observances were suspended. They were not counted as belonging to the year, but fell between the end of one year and the commencement of another. Four periods (*Tlalpilli*) of thirteen years each, made a cycle (*Xiuhmolpilli*) of fifty-two years. It will be seen that the fractional part of a day, which in our calendar is provided for by the intercalation of one day every fourth year, would in the course of fifty-two years, amount to *thirteen* days. That number of days was accordingly intercalated at the end of every cycle, so that each cycle commenced and ended upon corresponding days. Gama determined that the first year of the cycle (which was always *one Tochtli*) commenced on a day corresponding with our 9th of January. On account of the different modes of intercalation, it will be at once evident that, as compared with ours, the Mexi-

can year receded one day with every fourth revolution. So that the fifth year of the cycle commenced on a day corresponding with our 8th of January; the ninth year on a day corresponding with the 7th of that month, etc. By this constant recession, the last year of the cycle commenced on a day corresponding with our 26th of December, and consequently (deducting the five "*dead days*") must have terminated on the 21st of December, the precise date, as we have already seen, of the winter solstice.

This then may be laid down as the rule, in the scheme of the Aztecs. *That the cycle terminated when the last day of the year coincided with the date of the winter solstice.* And when we consider the influence which such a conjunction would be likely to have in a system with which the superstitions of the Aztecs were so closely interwoven, we shall be less disposed to look for the reason which determined the selection of the number of years constituting the cycle, in its multiples, however singular their combinations, than in the circumstance of the very conjunction here named.

No doubt a close dependence, I am not prepared to say how intimate, existed between this conjunction and the great secular festival of the Aztecs, celebrated at the end of every cycle. They believed that at the termination of one of these periods, the sun would never return, and the end of the world take place. This belief which was common to most primitive nations addicted to Sabianism, was, as observed by Humboldt, in the case of the Mexicans, "connected with the Toltic tradition of four *suns* or *ages*, at which periods the earth had undergone four great revolutions." Three of these destructions had taken place, according to the traditions, at the ends of cycles. At the end of each cycle therefore the deepest consternation prevailed. The five supplementary days were pas ed in great fear. On the fifth, the fires in the temples and houses were extinguished, the household utensils broken, garments rent, and whatever was deemed most precious destroyed. On the evening of this day, the priests dressed in the robes of the gods, followed by an immense procession of the people, went in solemn silence to the top of a high mountain near the city of Mexico, there to attempt the lighting of the new fire. The success of the attempt was an evidence of safety and of the benevolence of the gods. The fire was lighted, at midnight, by friction, upon the breast of a human victim sacrificed for the occasion. A great fire was then built and the sacred flame again distributed to the temples and houses. When the blaze was seen by the anxious spectators, the most extravagant joy was manifested, which was much augmented when the sun itself arose on the following morning, dissipating all fears with its effulgence.

The existence of this superstition, joined to the circumstance of the year terminating at a time when the recession of the sun was greatest, may have invested this period with so much importance as to make it a chronological era, from whence to date the years anew. However this may be, the conjunctions here noticed offer a better explanation of the singular selection of fifty-two years for the cycle, than is furnished by any analysis of the multiples of which that number is made up. It is not impossible however, that the further circumstance that the sacred numbers four and thirteen were multiples of fifty-two, may have had a secondary weight in the length of the cycle.

Passing by this question, we find that the discovery of the missing date of the winter solstice completes the circle of the sun's principal positions, as engraved upon the great Calendar Stone—a monument which still furnishes an interesting object of study, and the full understanding of which would no doubt tend greatly to increase our estimate of the astronomical knowledge and the ingenuity of the aboriginal Mexicans.

Note.—The apprehension of the extinguishment of the sun, at the winter solstice, is mentioned by Humboldt as affording a striking instance of the analogy which existed between the superstitions and religious observances of the ancient Mexicans, and the primitive nations of the old world. "When the Egyptians," says Achilles Tatius, "saw the sun descend from the Crab towards Capricorn, and the days gradually diminish, they were accustomed to sorrow from the apprehension that the sun was to abandon them entirely. This Epocha coincided with the festival of Isis: but when the orb began to reappear, and the days grew longer, they robed themselves in white garments, and crowned themselves with flowers."—*Humboldt's Res.*, vol. i, p. 383.

Art. XI.—*On the Comparative Value of different Kinds of Coal for the purpose of Illumination; and on Methods not hitherto practised for ascertaining the Value of the Gases they afford;* by Andrew Fyfe, M.D., F.R.S.E., F.R.S.S.A., Professor of Chemistry, King's College University, Aberdeen, &c. Read before the Royal Scottish Society of Arts.

(Continued from page 86.)

In the preceding part of this paper, I have shewn that gases from different coals not only require different times for the consumption of equal volumes, but that for these consumptions different pressures are necessary. It is of importance, therefore, to ascertain whether the consumption and the pressure bear the same ratio to each other, when different gases are used, that they do

when the same gas is employed. The consumption of gases, in some of the towns in England that I have visited, along with the pressure, was as follows,—the gases having been consumed from the same burner, and with the same height of flame:—

Gases.	Time for consumption of cubic foot by metre.	Pressure at burner in 100ths of inch	Square roots of pressures.	Time calculated by square root of pressure.	Difference between observed and calculated time.
	′ ″			′ ″	′ ″
Newcastle	50 30	11	3·31	. . . .	. . . .
Leeds	55 55	9	3	55 40	0 15
Liverpool	57 0	8·5	2·92	57 6	0 6
Manchester . . .	52 30	9	3	55 40	3 10

The following table gives the results with gases from Scottish parrot coal:—

Gases.	Time for consumption of cubic foot by metre.	Pressure at burner in 100ths of inch.	Square roots of pressures.	Time calculated by square root of pressure.	Difference between observed and calculated time.
	′ ″			′ ″	′ ″
Leshmahago,	85 0	42	6480	. . . .	. . . .
A.	59 20	80	8944	61 30	2 10
B.	69 5	64	8000	68 42	0 23
C.	65 50	72	8485	66 0	0 10
D.	90 50	38	6164	89 20	1 30

In the above tables, the experimental results agree very nearly with those given by calculation; and, accordingly, we may consider the consumption of different gases, from similar burners, and under similar circumstances, to be as *the square roots of the pressures* necessary to burn them, under these circumstances; of course, the times required for the consumption of equal volumes will be *inversely as the roots of the pressures.*

Another important circumstance still remains to be ascertained, viz., as the pressure necessary for the consumption of gases varies, and as the consumption also varies with the specific gravity, Is there any connection between the specific gravity of different gases and the pressures necessary for their consumption, under similar circumstances?

The following table gives the results of the consumption of gases under similar circumstances, along with the pressures and the specific gravities, taken in the usual way.

Gases.	Pressure in 100ths of inch.	Square roots of pressures.	Specific gravity by experiment.	Specific gravity calculated by square root of pressure.	Difference between experim'tal and calculated specific gravity.
E, ...	68	8246	580·6	. . .	. . .
F, ...	47	6855	697·6	698	0·4
G, ...	110	10488	458	460	2·0
Average of H, I, K, L, M, N, O, P, Q, R, S,	42	6480	732	738	6·0

The results, by experiment and by calculation, above given, so very nearly correspond with one another, that I think we are

warranted in concluding, that the pressure corresponds with the specific gravity, and that consequently the specific gravity may be ascertained by the pressure, when the gases are consumed under similar circumstances; having of course previously determined the specific gravity of a gas known to require a certain pressure for its consumption. Consequently the specific gravities being ascertained experimentally, the consumptions may be known; these being, *the times for equal consumptions, as the roots of the specific gravities,* and *the consumptions in equal times, inversely as these roots.*

Having established these positions, the next object I had in view was to ascertain, by a more extended series of trials, whether an indication of the consumption of gases, in different places, could thus be obtained, without having recourse to a metre, which, to an experimenter, carrying one from place to place, is troublesome. It at first occurred to me that this might be done by ascertaining the specific gravity; but this also must be a troublesome process, and unless ascertained with accuracy, would not tend to accurate results, especially in a hurried visit to different gas-works, where the height of the barometer cannot always be observed. After numerous trials, I at last determined to have recourse to the pressure-gauge, consuming the gas with a given height of flame, and always from the same burner. For this purpose, I used in my first trials the platinum-jet formerly alluded to, with an aperture of $\frac{1}{3^{1}_{4}}$ of an inch, furnished with a scale for measuring the height of flame, and with a pressure-gauge, to which a graduated scale, with a vernier, was applied, and by which the pressure at the burner, necessary to keep up the combustion at the desired height of flame, could be measured to 100ths of an inch. The diameter of the pressure-gauge was half-an-inch, which, though it gave a considerable curve in the fluid, yet afforded more accurate results than when one with a smaller diameter was used. Indeed, I had recourse to various contrivances, such as floats in the water, with indices attached to them, and made to move on the scale; but I found, after numerous trials, that the simple wide gauge was by far the best, provided that care was taken to mark the height of the fluid from the same part of the curve. I always marked it from the bottom; and for this purpose had brass plates passing round the tube, and movable, so that they could be brought to the curve in both limbs.

In the following set of experiments, the gases were prepared from a variety of coals by means of the experimental apparatus. They were always consumed with a five-inch flame. The illuminating power was tried by the chlorine test. The specific gravity was taken in the usual way, by filling a vessel of known capacity with the gas, and noting at the same time the state of the thermometer and barometer. Not less than two trials were

made with each coal, and the experiments with each gas were frequently repeated; and when it was necessary, other gases were made, and the trials again repeated, so as to secure accuracy. The consumption of the gas was ascertained in the usual way, by an accurate experimental metre; the trials with the specific gravity, the pressure, and chlorine, being frequently repeated. Instead of giving the names of the coals, I designate them by letters.

Gases.	Illuminating power by chlorine.	Pressure at burner in 100ths of inch.	Square roots of pressures.	Durability by metre, 1 foot min.	Durability calculated by square root of pressure.	Difference between experimental and calculated durability.
				′ ″	′ ″	′ ″
Standard.	24	42	6480	58	. . .	. . .
A.	8	122	11045	50	49·49	0·2
Aa.	11·5	80	8944	59·20	61·36	2·16
B.	13	76	8717	63 40	63·12	0 28
Bb.	15	64	8000	69·6	68·48	0·17
C.	15	72	8485	65·50	64·54	0 56
Cc.	15	63	7937	69 24	68·40	1·4
D.	15	60	7745	72	71	1·0
Dd.	17	56	7489	72 20	71·15	1·5
E.	23	40	6324	88·53	87	1·53
Ee.	24	38	6164	90·50	90·48	0·2
F.	19	50	7071	77·30	77·48	0·48
G.	22	46	6782	81·40	81	0·40
H.	12	79	8888	62·30	61·58	0·32
I.	22·75	38	6164	90·50	89·18	1·32
K.	12	72	8485	65	64·54	0·6
Average of the errors between the experimental and the calculated durability of the 16 trials, ...						′ ″ 0·42

From the foregoing table, it is evident, I think, that the mode of finding the consumption by the pressure is sufficiently accurate for all practical purposes. I mean, of course, merely with the view of finding the durability of gases, as I do not propose it as a method for superseding the use of metres, to ascertain the quantity of gas consumed by different individuals. I must mention, however, that in one or two instances, the observed pressure did not give the consumption, as indicated by the metre: whether this was owing to a peculiarity in the gas, or to inaccuracy in noting the results, I do not know. At the time that the experiments were performed, the results were merely marked down, and the calculations were made afterwards; and after discovering the want of correspondence, I had not then an opportunity of repeating the trials with the same coal, which was very remarkable for affording a gas of very high illuminating power. This was the more to be regretted, as the gas being at one extremity as to quality, made it appear, that there was some deviation from the rule I have laid down.*

* Since writing the above, I have fortunately had an opportunity of procuring the coal alluded to, and of preparing gas from it. All the trials were repeated with

From the foregoing experiments, it is evident that the durability of a gas can be easily ascertained, by using a burner with an aperture of a certain diameter, having a scale for measuring the height of flame, and a gauge for observing the pressure, at which the gas is burning, at that height of flame; of course taking care to make the measurement with accuracy. The consumption of any gas by this burner, with the height of flame fixed on, is first to be determined by metre, numerous trials being made; while, at the same time, at each trial, the pressure is also noted. By this means, and taking the average of all the consumptions and pressures, a standard is obtained. Suppose that with a flame of 5 inches, and a pressure of $\frac{7}{10}\frac{5}{0}$ths at the burner, the consumption of a gas is, by metre, found to be one foot in 65 minutes; and that another gas requires, with the same burner and height of flame, a pressure of $\frac{9}{10}\frac{4}{0}$ths; the square roots of these pressures are 8560254 and 9695359; then, as the latter is to the former so is 65, the time for the consumption of the latter, to 57·21, which is the time for the consumption of the former. Now $8560254 \times 65 = 5564165$; accordingly, this number divided by the square roots of the pressures necessary for the consumption of other gases, will give the times for the consumption of these gases, when consumed with the same burner, and with the same height of flame.

The jets now in general use, vary from the 28th of an inch, as recommended by Christison and Turner, to the 45th of an inch. Most of the trials which I have now recorded, were made with a jet of the 33d of an inch; not because I prefer it, but because I had begun my investigations with it, without being aware of the practical applications to which the results might lead; and having once begun with it, I thought it better to complete the experiments with it.

Since these experiments were finished, I have performed others, to enable me to find the best jet for the purpose now recommended. I had accordingly jets made with accuracy, the apertures in which were the 25th, 30th, 35th, 40th, 45th, and 50th of an inch; with all of which numerous trials were performed, to ascertain the consumption and pressure. I soon, however, rejected the first two, because they gave an unsteady flame; while the pressure-column in the gauge was not of any great length. With the remainder, the flame was more steady, and more easily measured, while the pressure column was of sufficient length to be easily marked. I soon, however, also, rejected the burner, No. 50, because unless the pressure on the street-pipes is great, it does

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great care, and were found to give results corresponding with those in the above table, so that there must have been an error in noting the results of the first trials. In the subsequent trials, repeated again and again, the consumption by metre and calculated by pressure differed only in 40 seconds.

not give a flame of sufficient height; indeed the same is sometimes the case with jet 45. For these reasons, I now prefer the jet 40, because, while it gives a very steady flame at 5 inches, the water-column in the gauge is much longer than when a jet 33 or 35 is used; and thus, any slight inaccuracy, in noting the pressure, leads to a smaller error in the results, than when the same inaccuracy is committed, in noting the pressure when the water column is not so long.

The following is the result of trials made with the different jets I have mentioned:—

Trials with Flame.

4 Inches.				5 Inches.			
Jets.	Pressure in 100ths of inch.	1 foot burned minutes.		Jets.	Pressure in 100ths of inch.	1 foot burned minutes.	
		′	″			′	″
25	15	75	35	30	50	65	25
30	30	75	30	33	68	64	25
33	44	75	41	35	110	65	0
40	90	72	55	40	120	63	40
45	110	72	30	45	155	64	40
50	196	75	0				

On viewing the results above given, it will be observed, that the times for the consumption of 1 foot are very nearly the same. Had the difference followed any regular gradation, then we might have supposed that it was occasioned by the difference in the size of the aperture in the jet; but as it does not do so, we may, I think, safely conclude, that, with jets of different apertures, and with flames of the same height, the quantity of the same gas consumed in the same way is the same; or that the times for equal consumptions are the same. That this is really the case is still farther proved by taking a small jet of gas, of given height of flame, and marking the consumption by metre; then removing the jet from the socket, which is left open, and consuming the gas from it; the quantity in the same time, will be found to be the same. Or, burn the gas from the latter, with a flame of such a height as can be measured with any degree of accuracy; then introduce a jet, and burn the gas with the same height of flame; the quantities consumed are the same, or as nearly so as can be expected from trials of the kind, where it is difficult to measure accurately the length of flame. Hence, most probably, the cause of the difference of time in the table given; that difference having been occasioned by the flame in some of the trials having been a very little too high or too low, in the cases where the difference is greatest. Even that difference, especially in the last table, the experiments of which were repeated again and again, with slightly varying results, is only 1′ 20″. This shews the necessity of repeated trials, altering the flame, and again bringing it to the fixed height, and each time marking the con-

sumption and the pressure, so that, by taking the average of many trials, an accurate result may be obtained. Having fixed on the jet 40, bushed with platinum, and furnished with the scale for the flame, and with the pressure-gauge, I found, by numerous trials, that the time for the consumption of 1 foot of a gas, was 64′ 41″, the flame being 5 inches. The pressure at the burner-gauge was $\frac{1}{7}\frac{1}{8}\frac{7}{8}$ths. The specific gravity of the gas was, by experiment in the usual way, found to be 602·6, at 60°, and barometer 30; of course one foot requiring 64′ 41″, then in 60′, there are consumed 0·927 of a foot. Thus, then, the consumptions being, in equal times, as the square roots of the pressures, and the times, for equal consumptions being inversely as the square roots, while the specific gravities are also inversely as the square roots of the pressures, the following table will give the consumption of gases in 60 minutes, the time for the consumption of a foot; and the specific gravity, at 60°, and barometer 30, calculated from the square roots of the pressures, the gases being consumed, with a flame of 5 inches from the jet 40; taking, as I have already stated, a gas of specific gravity 602·6, burning under a pressure of $\frac{1}{7}\frac{1}{8}\frac{7}{8}$ths, 1 foot in 64′ 41″; the square root of pressure 117 being 108166.

Should any other jet be found preferable, the quantity of gas consumed by it, with a flame of a fixed height, must be ascertained by repeated trials, with an accurate experimental metre; taking the pressure accurately each time. The average consumption and pressure being thus fixed on, the specific gravity is to be taken by experiment in the usual way; then the consumptions and specific gravity of other gases, with the same burner and height of flame, will be found, as already directed, with jet 40; and for which the table has been constructed.

TABLE, *shewing the Times for Equal Consumptions, the Consumptions in Equal Times, and the Specific Gravities of Gases, requiring the following Pressures to burn them, from Jet* 40, *with a* 5*-inch Flame.*

Pressure in 100ths of inch.	1 foot burns min.		100ths of foot in 60 mins.	Specific Gravities, Air=1000.	Pressure.	1 foot burns min.		100ths of foot in 60 mins.	Specific Gravities, Air=1000.
	′	″				′	″		
60	90	18	66·6	841·4	75	80	48	74·1	752·6
61	89	36	66·9	834·5	76	80	16	74·5	747·6
62	88	48	67·5	827·7	77	79	45	75·1	742·8
63	88	10	68·0	821·2	78	79	14	75·7	738·3
64	87	28	68·5	814·7	79	78	44	76·3	733 3
65	86	48	69·1	808·4	80	78	12	76·7	728 7
66	86	8	69·6	802·3	81	77	42	77 2	724·3
67	85	30	70·1	796·3	82	77	12	77·7	719·8
68	84	48	70·6	790·4	83	76	48	78·1	715·4
69	84	15	71·0	784·6	84	76	12	78·7	711·1
70	83	36	71·7	779·0	85	75	54	79·1	706·9
71	83	0	72·2	773·5	86	75	24	79·5	702·8
72	82	30	72·6	768·1	87	75	0	80·0	698·8
73	81	54	73·2	762·8	88	74	36	80·4	694·0
74	81	21	73·7	757·8	89	74	6	80·9	690·9

TABLE, *shewing the Times for Equal Consumptions, &c.*—Continued.

Pressure in 100ths of inch.	1 foot burns min.		100ths of foot in 60 mins.	Specific Gravities, Air=1000.	Pressure in 100ths of inch.	1 foot burns min.		100ths of foot in 60 mins.	Specific Gravities, Air=1000.
	′	″				′	″		
90	73	45	81·4	687·0	146	57	54	103·7	539·4
91	73	18	81·7	683·3	147	57	42	104·0	537 6
92	72	57	82 1	679·5	148	57	30	104·3	535·8
93	72	34	82·5	675 8	149	57	18	104·6	534·0
94	72	6	83·1	672·3	150	57	6	104·9	532·2
95	71	48	83·5	668·7	151	56	54	105·4	530·4
96	71	24	83·9	665·2	152	56	45	105·8	528·7
97	71	00	84·1	661·8	153	56	33	106·1	527·0
98	70	36	84·9	658·4	154	56	19	106·4	525 3
99	70	18	85·3	655·1	155	56	12	106·8	525·6
100	69	58	85·7	651·8	156	56	0	107·1	521·9
101	69	36	86·2	648·6	157	55	48	107·4	520·2
102	69	12	86·7	645·4	158	55	39	108·0	518·5
103	68	54	87·1	642·2	159	55	30	108·4	516·9
104	68	36	87·5	639·1	160	55	19	108·8	515·3
105	68	15	87·9	636·1	161	55	9	109·7	513·7
106	67	58	88·2	633·1	162	54	59	109·1	512·1
107	67	36	88·6	630 1	163	54	48	109·4	510·5
108	67	18	89·1	627·2	164	54	38	109·7	508·9
109	67	0	89·5	624·4	165	54	29	110·1	507·4
110	66	42	89·9	621·5	166	54	19	110·4	505·9
111	66	24	90·3	618·6	167	54	9	110·8	504·4
112	66	6	90·7	615·9	168	53	59	111·1	502 9
113	65	48	91·0	613·2	169	53	50	111·5	501·4
114	65	30	91·4	610·5	170	53	41	111·8	499·9
115	65	15	91·9	607·8	171	53	31	112·0	498·4
116	64	58	92·3	605·2	172	53	21	112·5	497·0
117	64	41	92·7	602·6	173	53	12	112·7	495·6
118	64	24	93·1	600·0	174	53	3	112·9	494·2
119	64	9	93·5	597·5	175	52	54	113·3	492·8
120	63	48	93·9	595 0	176	52	45	113·6	491·4
121	63	36	94·3	592·5	177	52	36	114·0	490·0
122	63	21	94·7	590·1	178	52	27	114·3	488·6
123	63	6	95·1	587·7	179	52	18	114·7	487·2
124	62	50	95·4	585·3	180	52	9	115·0	485·8
125	62	35	95·8	582·9	181	52	0	115·3	484·5
126	62	18	96·2	580·6	182	51	52	115·5	483·2
127	62	6	96·6	578·3	183	51	43	115·8	481·9
128	61	51	97·0	576·1	184	51	34	116·2	480·5
129	61	36	97·4	573·9	185	51	27	116·6	479·2
130	61	21	97·8	571 7	186	51	19	117·0	477·9
131	61	8	98·2	569·5	187	51	12	117·3	476·6
132	60	54	98·6	567·3	188	51	2	117·6	475·3
133	60	36	99·0	565 2	189	50	54	117·9	474·1
134	60	27	99·3	563·1	190	50	46	118·2	472·9
135	60	12	99·6	561·0	191	50	37	118·5	471·6
136	60	0	100·0	558·9	192	50	30	118·8	470·4
137	59	45	100·3	556 8	193	50	22	119·0	469·2
138	59	33	100·7	554·8	194	50	14	119·4	468·0
139	59	21	101·1	552·8	195	50	6	119·7	466·8
140	59	8	101·5	550·8	196	49	59	120·0	465·6
141	58	54	101·9	549·0	197	49	51	120·3	464·4
142	58	42	102 3	547·0	198	49	44	120·7	463·2
143	58	30	102·6	545·1	199	49	36	120·9	462·0
144	58	18	102·0	543·2	200	49	29	121·1	460·8
145	58	6	103·3	541·3					

Before concluding I wish to advert briefly to a mode of fixing the illuminating power, which, so far as I am aware, has not been publicly noticed in any of the papers lately printed. Dr. Lyon Playfair, who described it to Mr. King of the Gas Works, Liverpool, from whom I first got the account of it, ascribes it to Professor Bunsen of Marburg; and, accordingly, as I understand, he has the merit of proposing it. It consists of a sheet of paper, besmeared with spermaceti, excepting at a small part at the centre, by which the besmeared portion becomes more pervious than the other to light; and consequently a light placed behind it, causes a dark spot on that part not covered. When another light is placed before the paper, the spot is distinctly visible, if that light be placed at such a distance as to cause the reflexion from the paper to be either of greater or of less intensity than that transmitted. When however, it is so situated that the transmission from behind, and the reflexion from before, are of the same intensity, then the spot is invisible; the paper appears as if uniform throughout. Now, with a light of uniform intensity placed behind, the transmission will always be the same. If another light before the paper requires to be at the distance of 5 inches, and another at 10 inches, to cause, one after the other, the spot to disappear, then, according to the usual law, they are giving light as 25 and 100, *i. e.*, 1 to 4. After a little practice I have found this photometric process extremely delicate. It has many advantages over the shadow test: for instance, the difference in the color of the shadow is avoided; besides, the trials can be conducted without darkening the room, unless there are cross lights or sunshine directly into the apartment.

With regard to the light to be placed at the back of the screen, the only uniform source with which I am acquainted is a wax or spermaceti candle, of the same diameter, and with the same thickness of wick. With regard to the modes of preparing the paper, I at first used spermaceti melted, as recommended by Mr. King, and applied it to bibulous paper in various ways; but I never succeeded in getting it uniformly spread over the surface,—it was generally thicker at one part than at another, which gave rise to a difficulty in fixing the distance at which the light should be placed. After trying different methods, I have, however, succeeded in getting the paper properly prepared. The process I now follow, is to dissolve spermaceti in distilled oil of naphtha, till it gives a mixture, which at natural temperatures is solid; but is liquefied by the application of *a very slight heat*, such as by holding the vessel in the hand for some time. When fluid, it is to be applied by a hair-pencil to the paper, leaving a part of about the size of a half-crown piece at the centre uncovered. After this the paper is held *horizontally* over a lamp, *and very cautiously heated*, by which all inequalities disappear. I prefer the fine cream-colored paper now much used as letter paper.

A screen fitted up in this way, stretched on a frame, with a holder for the light at the back, and with another holder in front for the other light, is all that is required: of course, if gases are to be tried, the holder in front must be furnished with a jet of the diameter previously fixed on, and with a flexible tube to be connected with the gas-pipe. This holder can be made to move backwards and forwards on a scale, graduated to inches, with their corresponding squares; or to lights of candles, as may be thought proper. To make the apparatus more complete, the gas-jet can be furnished with the pressure-gauge, which I have recommended for ascertaining the durability; and thus, by the two together, the *value* of gases may be quickly ascertained.

This mode of trying the illuminating power will be found very useful; not that I prefer it to the chlorine test, for by the latter, all gases can be compared with a standard of unity, the illuminating power being just as the condensation; but because the former is easily managed, especially by those not practised to work with water-troughs. Could a truly uniform source of light be procured, and, by general consent, be fixed on, as that for the back of the screen, then the light from gases, or indeed from other sources, could be compared with it; but as yet, we are not so far as I am aware, in possession of such a light.

With the use of the screen now described, I was anxious to repeat the trials made, with the view of ascertaining the light for equal consumptions of gases by different burners; an account of which was published in the Transactions of the Society for 1842, because I have again and again heard the accuracy of these results called in question. In conducting the trials, I had, as before, recourse to an experimental metre, to ascertain the consumption, and made use of a gas-jet flame, always of the same height, and always at the same distance from the back of the screen. Each series of trials being conducted in one day, the gas was, of course, of the same quality for each day, by which a uniform transmission of light from behind was obtained.

The following are the average results:—

Burners.	Consumption in 60 minutes.	Light by flame.	Light for equal consumptions.
Jet—flame 5 inches,	1 foot.	1·00	1·00
Small Fishtail,	1·98	2·89	1·45
Large Fishtail,	2·60	4·00	1·53
Small Batwing,	3·00	4·40	1·46
Large Batwing,	4·60	8·40	1·87
Argand, 40 holes,	4·50	7·84	1·74

In the paper published in 1842, it was stated that the most profitable way of consuming gas is by the Argand, properly constructed; in other words, that for equal consumptions, the greatest amount of light is given by the Argand; next by the batwing;

then by the fishtail; and, lastly, by the jet, which is the least economical; and, consequently, lighting by gas is comparatively, for equal amount of light, by far most expensive to those having recourse to this mode of burning it, such as to those requiring small quantities. The light, as then stated, was in the ratio of 100, 140, 160, 180. In the trials now recorded, the results do not all correspond with these. With the small fishtail and the Argand they do so very nearly; the burners used having been the same as formerly. The others, such as the large fishtail, not formerly tried, is more economical than the small fishtail; the small batwing, also not formerly tried, is not more economical than the small fishtail, and much less so than the large fishtail. The large batwing, the largest I have ever seen, is equally economical with the Argand: I found it very liable to smoke. The general results of these trials may, however, be said to correspond with those previously given, proving the accuracy of my former statement, that the jet is the worst kind of burner, giving least light for the same consumption; next come the fishtails, generally speaking; then the batwings of medium size; and, lastly, the Argand.

ART. XII.—*Notes on some Chenopodiaceæ, growing spontaneously, about the City of New York;* by JOHN CAREY.

MY attention having been directed, during the past autumn, to the Chenopodiaceous plants of this vicinity, I was surprised to find, growing in considerable abundance about the waste lots in the first and second avenues of the city of New York, (near 14th street), a plant, which, though differing in some slight particulars, I cannot doubt, is the *Roubieva multifida*, Moq.-Tand. (Chenopodium multifidum, *Linn.*, Atriplex multifida, *Crantz*, C. Payco, *Molin. Chil.*, Ambrina pinnatisecta, *Spach*, *Veg. Phan.*) This synonymy I derive from the elaborate *Chenopodearum Monographica Enumeratio*, of Moquin-Tandon, where I find the species referred to South America, and the Cape of Good Hope. I am not aware that it has hitherto been noticed in any of our Floras, as occurring in the United States, nor have I ever seen a specimen; with the exception of a small piece in the herbarium of my friend Professor Torrey, which he appears to have received, without a name, from "Virginia, Dr. Aikin, 1843." Feeling some interest in this discovery, I have been led to examine the characters of the genus *Roubieva*, founded on this single species, as contrasted with the subsequently published *Ambrina* of Spach, who proposed to comprehend the *Chenopodium multifidum*, L., within its limits; being ignorant, no doubt, of the prior genus

established by Moquin-Tandon. I regret that I have not the means of referring to the original paper of Spach for the character of the genus *Ambrina*, which, as given by Moquin-Tandon, differs chiefly from that of *Roubieva* in the 2 (not 3) styles, and in the comparative length of the embryo with respect to the albumen, it being "$\frac{2}{3}$ to $\frac{3}{4}$ annular" in *Ambrina*, and completely so in *Roubieva*. The inflorescence of the former is described as "spicate-paniculate," and of the latter, very correctly, as having "axillary, solitary or glomerulate flowers, the glomerules being sometimes almost verticillate."* Upon examination of the three species of *Ambrina*, growing abundantly in the same neighborhood with *Roubieva*, I do indeed find that *A. Botrys*, Moq.-Tand., (referred by Spach to his genus *Botrydium*,) has commonly but two styles—though I have detected three, occasionally: but *A. ambrosioides*, Spach, and *A. anthelmintica*, Spach, have constantly, or with very rare exceptions, three styles; which as to the latter species, is noticed by Moquin-Tandon himself. With respect to the inflorescence, I find that three species are described by this author, under *Ambrina*, as having few-flowered, axillary glomerules, *not spicate*, viz. *A. carinata*, and *A. Pumilio*, from New Holland, and *A. tenuis*, from Chili. These exceptions being admitted, the genus *Ambrina*, including (as arranged by Moq.-Tand., though not by Spach) species with horizontal and vertical fruit, would seem to rest mainly upon the *incompletely* annular embryo; for, I do not find the (rather dilated) filaments in *Roubieva* "somewhat inserted into the perigonium," but as in *Ambrina;*

* As the above cited valuable work is known to very few American botanists, I extract, for their information, the full generic characters, as follows:

Roubieva. *Moq. Ann. Sc. nat.* 2. *ser.* 1, *p.* 292, *t.* x, *f. B.*—Flores hermaphroditi, ebracteati. Perigonium profundè urceolatum, oblongum, quinquefidum, nunquam appendiculatum; laciniis demum coalitis, subpentagonam rugosamque capsulam efformantibus. Stamina 5, imo perigonio inserta. Stigmata 3, longa, subulata. Fructus (utriculus) compressus, perigonio capsulari involutus (et dimidio brevior); pericarpio membranaceo, punctis resinosis consperso. Semen verticale, lenticulare; integumento exteriore crustaceo. Albumen copiosum, farinaceum, candidissimum. Embryo annularis; radicula infera.—Herba, prostrata, diffusa, pubescens. Folia alterna, pinnato-multifida; laciniis dentatis. Flores solitarii aut glomerulati (glomerulis interdùm feré verticillatis), axillares. Stamina quandoque abortiva, unde flores feminei. * * Facies Senebieræ pinnatifidæ. Planta odorem ambrosiacum spirat. Radix angustè fusiformis, longa. Capsula reticulata. —*Moq.-Tand. l. c.* p. 42.

Ambrina. *Spach, Veg. Phan.* 5. *p.* 297 *et* 299, char. reform.—Flores hermaphroditi, ebracteati. Perigonium quinquefidum vel quinquephyllum (interdum 3-4 fidum), nunquam appendiculatum. Stamina 5, rarissimè pauciora, receptaculo inserta. Styli 2, infernè coaliti. Fructus (utriculus) depressus aut compressus, perigonio clauso involutus, interdum suprà nudus foliolis imperfectè clausis; pericarpio tenui, distincto. Semen horizontale aut verticale, lenticulare; integumento exteriore crustaceo. Albumen farinaceum. Embryo $\frac{2}{3}$ aut $\frac{3}{4}$ annularis.—Herbæ pubescentes, aut subpubescentes, glandulosæ et graveolentes (haùd farinosæ). Folia alterna, petiolata, dentata, sinuata aut pinnatifida. Flores minutissimi, spicatim paniculati.—Genus inter Chenopodium et Blitum intermedium, Roubievæ affine. Semina nunc horizontalia ut in Chenopodio, nunc verticalia ut in Blito; sed embryo totum non perficit annulum et vix albuminis $\frac{2}{3}$ aut $\frac{3}{4}$ includit. Pubescentia glandulosa et odor aromaticus valdè naturalem constituunt seriem.—*Moq.-Tand.*, l. c. p. 36.

nor do I remark the "deeply urceolate" perigonium. If the above three species of *Ambrina*, with few axillary flowers, and of which Moquin-Tandon had not sufficient knowledge, should prove rather to belong to *Roubieva* by having a *completely* annular embryo, the genus *Ambrina* may perhaps be considered as confirmed; but, otherwise, though with due deference to the great authority of Moquin-Tandon who has adopted it, I cannot regard it as other than a (not very marked) section of *Roubieva*—since the admitted species of *Ambrina* differ in the *degree* in which the embryo surrounds the albumen, and the generic character is drawn accordingly.

Elliott remarks of *A. anthelmintica*, that "it is probably our only indigenous species" (of Chenopodium), adding: "the specimens of this plant which I have received from the Eastern States differ from ours by leaves less rugose, dentate not sinuate, and flowers in detached clusters (glomerules), not in paniculate spikes as with us." This form I also find here; and have thought that it might possibly be a hybrid, as it grows intermingled with the Southern (typical) state of *A. anthelmintica*, and *A. ambrosioides*, and has, in fact, a very intermediate appearance, between them.

Chenopodium rhombifolium, Muhl., is considered by Moquin-Tandon as a variety (*β. rhombifolium*) of *C. urbicum*, *Linn.*; but, though what I suppose to be the plant of Muhlenberg, and of Darlington, Fl. Cest., grows very abundantly in the upper part of the city of New York, and elsewhere in the United States, I never saw a specimen actually agreeing with the European type of *C. urbicum*, from which I believe our plant to be distinct.*

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* This species attracted the particular notice of that accomplished naturalist, Dr. Wm. A. Bromfield, of the Isle of Wight, who kindly directed my attention to an immature specimen which he gathered in the suburbs of Philadelphia. This intelligent traveller also informed me that he had observed *Chenopodium glaucum*, a species which has not passed under my notice, growing in the same city. In his very interesting "Notes and Observations on the Botany, Weather, &c., of the United States of America," Dr. Bromfield has the following remarks on these and other Chenopodiaceous plants which he saw in the neighborhood of this city, and Philadelphia. "I found *Chenopodium glaucum* growing in the dockyard (at Philadelphia) on moist spots near the water, and on a large piece of waste ground at the end of Fourth street; this is, I believe, a rare species in America, and probably of comparatively recent introduction, as the botanists of that country, and even of Philadelphia, seem very little or not at all acquainted with it. Four other species of the same genus, *C. album*, *ambrosioides*, *anthelminticum*, and *botryoides* (C. Botrys, L.? C. botryodes, Sm., being a var. (β. crassifolium) of Blitum polymorphum, C. A. Mey. fide Moq.-Tand.) are found in waste places in and around the city, besides a fifth, allied to our *C. urbicum*, but certainly distinct from that and *C. rubrum*, for which last, I believe, it passes here, and to which I am desirous of drawing the attention of American botanists, as being probably a non-descript. The plant has much resemblance to C. anthelminticum in its inflorescence, but is quite destitute of the strong smell of that species, and it resembles *C. urbicum* in the slender, erect, somewhat branched, nearly naked racemes, that bear a few small leaves amongst the lower clusters only. It is more branched and spreading than either of the two, or, indeed, than in any of the upright forms of the European *C. rubrum* that have come under my notice, which it was pronounced to be (I am sure erroneously) by some botanists of the town, to whom I showed it at a meeting of the Horticultural Society of Philadelphia. The only speci-

The leaves vary greatly in size, and *when young* are white and mealy beneath, in which state it has a resemblance to *C. glaucum*. By American botanists it has been very commonly referred to *C. rubrum*, L. (*Blitum polymorphum*, C. A. Mey.) a very different plant, with vertical fruit, and of which I have seen no American specimen. The "*C. urbicum*, L. ?" of Fl. Bor.-Am., under which is cited *C. intermedium*, Mert. and Koch, is *C. hybridum*, L., as I ascertain from an authentic specimen in Dr. Torrey's Herbarium, labelled "*C. intermedium*, *Fl. Bor.-Am.*" Indeed, Hooker remarks that the plant "exactly accords with the C, hybridum" of the English Botany; and that it was what he had "received from the American botanists as C. hybridum: but that species has a more panicled inflorescence with divaricating branches." In this particular the plant probably varies with growth as it certainly does in some other characters. I have two varieties from my friend, Mr. S. T. Olney, of Rhode Island; one with a green stem, naked panicles, and leaves cordate at the base; the other with a red stem, somewhat leafy panicles, and leaves acute at the base. *Chenopodium intermedium*, Mert. and Koch, is adduced by Moq.-Tand. as a variety (γ. intermedium) under *C. urbicum*, and the short character he gives would not seem applicable to C. hybridum. I have not, however, the means of determining this discrepancy in the synonymy. I do not remember to have noticed *C. hybridum* in the suburbs of New York, though it doubtless occurs there, as I have observed it growing at Hoboken. Indeed, it is probable that these homely weeds are often overlooked or mistaken, where they are not uncommon. *C. murale*, L., hitherto considered rare, I find growing about the waste lots, in this city, and at Hoboken; and have received it from Mr. Olney, who collects it about Providence. I also find it in the Herbarium of Dr. Torrey, from Prof. Short of Kentucky, together with *C. hybridum*, the latter gathered "amongst the almost inaccessible cliffs of the Kentucky river." It is certainly difficult to determine which of these species should be considered as strictly native plants, but, although the whole are arbitrarily excluded by Nuttall, there seems no good reason why some of them, at least, should be less so than the common species of *Ambrina*, which, he asserts, "only are indigenous."

New York, November 30, 1848.

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mens I collected for examination were picked at the entrance to the wharves and woodyards of Kensington, where it occurs frequently. * * * I have not seen it in fruit, the plant having quite disappeared when I sought it again in the November following. * * *Chenopodium murale* grew near our starting point at Camden (New Jersey); an apparently uncommon plant in America, and perhaps introduced. I remarked it, however, in some plenty under walls at the Castle Garden in New York, and very commonly about Norfolk, Virginia, corresponding exactly with specimens from the Isle of Wight."—*Hook. Lond. Journ. Bot.*, *April*, 1848, p. 211.

APPENDIX.

As my communication of November 30th was too late for the last number, I am now enabled to add a further note, derived from "*The Botany of Capt. Beechey's Voyage*," to which I have only just procured access. A Californian plant, considered by the authors as a probable variety of *Chenopodium anthelminticum*, L., is there referred to *Roubieva*, Moq.-Tand., and the following observation appended to the description.—"The genus Roubieva of Moquin-Tandon, distinguished from Chenopodium by its vertical seed, and from Agathophytum by the keeled segments of its perianth, which form a pentagonal covering to the nut, was constituted for one or two South American species, but ought to include the present plant and a few others indicated by Spach under his Ambrina, which does not differ."—*Suppt. Bot., Beechey's Voy.*, 1841.

It would hence appear that my view of the identity of the genera *Roubieva* and *Ambrina* (the latter as constituted by Spach) has been anticipated by Hooker and Arnott, but, from their contrasting characters, as given above, these distinguished botanists did not seem to contemplate the admission of the species with horizontal seeds, constituting the genus *Botrydium* of Spach, but which is reduced by Moq.-Tand. to a section (*Botryoïs*) of the genus *Ambrina*. J. C.

January 22d, 1849.

ART. XIII.—*Analysis of the Braunau Meteoric Iron;* by Dr. N. W. FISCHER.*

(Continued from vol. v, p. 342.)

IN the enquiry instituted by Prof. Duflos and myself, we made use of the filings which, as has been mentioned, I had been permitted to remove from the mass during my presence at Braunau, and we could thus only treat of the iron as a homogeneous body. Now however having, by the especial kindness of Dr. Rotter, been put into possession of a solid mass of more than 20 grammes in weight, my attention was primarily directed to ascertain of what heterogeneous substances this meteoric iron consists; and the results at which I have arrived are, that it contains three such bodies.

One of these is by far the most predominant, forming the general mass, and is a compound of iron, nickel and cobalt, with traces of other substances, as stated in the result to which our investigations led us.†

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* Translated by W. G. LETTSOM, Esq., of London, from Poggendorf's Annalen, vol. lxxii, p. 575, and communicated by the translator to this Journal.

† Several of the substances alluded to there, are probably attributable to the presence of the two other bodies

The second body occurring imbedded here and there in the general mass, and which is readily distinguishable therefrom by its color, fracture, brittleness and lustre, may be extracted without much difficulty by mechanical means.

The third, in fine, can be separated from the meteoric iron in the form of small plates or spangles, by allowing the action of chlorohydric acid to continue thereon as long as a solution goes on forming.*

I do not consider that there is ground for regarding the black powder, which is separated by the action of the acids, as also a peculiar and distinct body, inasmuch as it contains the several constituents of the general mass, which are thus separated owing to their insolubility in the acids employed.

Although my endeavors were directed towards ascertaining the ratio of the constituents of these two substances, that is to say, the bodies two and three, yet from the extremely minute quantity thereof at my disposal, I was forced to confine myself principally to their qualitative examination.

1. *The imbedded substance.*—Diluted chlorohydric acid which does not exert any action upon the principal mass for some time, disengages at once a considerable quantity of sulphuretted hydrogen when poured on to this body, dissolving it completely, with the exception of a minute residue in the form of a greyish black powder. The hydrogen given off by the general mass during its solution in chlorohydric acid has not, it must be observed, the slightest smell of sulphuretted hydrogen with it, unless some of these scales or spangles happen to be present. This powder when transferred to a strip of thin platina foil and exposed to a moderate heat takes fire, glimmering like tinder, a phenomenon which is repeated upon the foil attaining a red-heat. The powder which has now become of a brown color was fused with nitrate of soda on platina foil and exposed to a red-heat. On becoming cold the salt was of a yellow color, which color it retained when dissolved in water. This solution after being neutralized with nitric acid —for the double purpose of converting both the caustic soda and the nitrite of soda into a nitrate—produces in a solution of nitrate of silver a beautiful red precipitate, readily soluble both in nitric acid and in ammonia, from which solution it is a second time thrown down, of the same brilliant red color as before, by reciprocally rendering the solution neutral; that is to say, the nitric solution by ammonia, and the ammoniacal solution by nitric acid.†

* Berzelius found a body of a similar nature in the meteoric iron of Bohumilitz, and which he termed scales, they were however white, more granular and heavier, and could therefore be separated by adulceration from the carbonaceous powder disengaged at the same time with them from the mass, a proceeding that is only partially successful with the minute spangles in question.—(See Pogg. Annal., vol. xxvii, p. 122.)

† The reaction given here for chromic acid appears to me to be at once very characteristic and sure, added to which, it is remarkably simple.

The chlorohydric solution contains iron and a small quantity of nickel.

The ratio of the portion soluble in chlorohydric acid to the insoluble is in 100=97 : 3.

(I had not above 0·073 grm. at my disposal for this examination, of which 0·002 remained undissolved.)

The constituents of this substance are consequently

Iron, Sulphur, } in 100=78·9 simple sulphuret of iron.
Nickel.
Chromium.
Carbon.

From the 0·073 grm. employed, the amount of peroxyd of iron thrown down from the chlorohydric solution was 0·083, consequently equal to 0·057 of metallic iron. This, in order to form simple-sulphuret of iron would require 0·033 sulphur; the sulphuret of iron would therefore alone amount to 0·090, that is to say, more than the weight of the body employed. A minute portion of the iron must therefore be combined with nickel, carbon and chrome in the body under examination. I was not able to detect the presence of phosphorus therein.

2. *The metallic scales, or spangles.*—Easy a matter as it is to obtain the first substance in a state of purity, namely, by separating it from the principal mass by mechanical means, it is one of equal difficulty to obtain this body free from those substances which, like these scales themselves, are left as a residue after the action of chlorohydric acid upon the mass, namely, carbon, silica, &c. The quantity of this substance obtained is moreover extremely limited, scarcely indeed exceeding one per cent. of the mass even when taking into account the powder with which it is separated in common.

Chlorohydric acid exerts no action whatever upon this substance, and nitric acid attacks it but very slightly; in nitro-muriatic acid however, it is readily soluble by the application of heat, leaving merely a slight residue of silica.

This solution when completely evaporated to dryness, leaves a residue, on the surface of which there is a formation of shining reddish-yellow scales easily detached from the glass; the inferior portion consists of a yellowish white mass adhering thereto. Both are completely insoluble in water, yet the white mass, provided it has been dried by a gentle heat, passes with the water through the filter; when a strong heat on the other hand has been employed to dry it, the white mass remains upon the filter, as do also the yellow scales. Both portions of the residue are readily soluble with a yellow color in chlorohydric acid, their behavior being that of basic phosphate of the peroxyd of iron.

Heated upon platinum foil this substance, like the former one, takes fire at a moderate heat, glimmering like sugar, losing thereby its metallic lustre and being converted to a brown powder from which both chlorohydric and nitric acids dissolve out a considerable portion.

The constituent parts of this substance are:

Iron, phosphorus, nickel, carbon and silica. Berzelius in the scales from the Bohumilitz iron found the *same constituents* in the following proportions: but whether those proportions obtain in the scales now under examination, I could not from the small quantity at my disposal, (=0·047 gramme,) ascertain.*

Iron	65·977
Phosphorus	14·023
Nickel	15·008
Carbon	1·422
Silica.†	2·007

The iron was the only element I endeavored to determine approximately, and in the present case it amounted to 51 per cent. or thereabouts.

These two substances, both the imbedded one and the scales, form. disregarding the other constituents, a remarkable contrast. The former consisting principally of sulphuret of iron, and the latter of phosphuret of iron. Another peculiarity is that the former substance occurs only here and there, and comparatively speaking, in considerable masses; while the second substance on the contrary, is generally diffused throughout the mass and in such very minute spangles:—this difference in the disposition of the two bodies being probably to be accounted for by their different fusibility and setting-point upon cooling.

The phosphuret of iron separates at a temperature at which the sulphuret of iron still remains in fusion, thus allowing the latter to unite into larger masses.

That the scales are very generally diffused through the mass is proved by the action of chlorohydric acid, for even in a very little while they are thus rendered visible, especially upon shaking the fluid, which causes them to float about therein. This conduct tends at the same time to establish their minuteness and levity, inasmuch as in spite of their general diffusion they do not amount to one per cent. of the mass, and this even when taking into account the carbonaceous powder separated simultaneously with them.

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* Berzelius had it in his power to employ about 60 grammes of the meteoric iron to obtain the scales, and the quantity he thus procured amounted to about 0·777 gramme. All that I had to work upon was about 5 grammes, inasmuch as I had lost a considerable portion of the iron I had through an accident, which I will subjoin in a note at the close of this Paper as a caution to other experimenters.

† See Berzelius in Poggendorf's Annal., vol. xxvii, p. 131.

In the Bohumilitz meteoric iron, the scales with the powder amounted to 2·26 per cent., alone 1·3 per cent.

Additional Note.—In order to obtain a sufficient quantity of these scales, I had put my entire stock of iron (previously broken up into fragments) into a small bottle—one of Faraday's washing-bottles—and had poured chlorohydric acid upon it, and had closed the bottle by means of a small cork into which a long narrow tube bent at an obtuse angle was adapted. After allowing the action of the acid to continue 16 hours, I approached the small flame of a spirit-lamp with a single wick, to the elbow of the tube, in order to ascertain whether the hydrogen given off contained arsenic, when after a short interval a violent explosion took place shattering the bottle to pieces.

That under these circumstances, in spite of the long continued action of the acid, the bottle should be still filled with an explosive mixture of gases, is noways surprising, it is however remarkable, that the gas thus formed should explode so very speedily upon the tube being gently heated. The explosion is probably to be ascribed to the hydrogen, containing also sulphur or phosphorus, though perhaps only in minute traces. As the bottle was completely broken to pieces, I was enabled to find again only a few small portions of the meteoric mass operated upon, and these were employed to obtain the scales.

ART. XIV.—*On the Acid Springs and Gypsum Deposits of the Onondaga Salt Group;* by T. S. HUNT, of the Geol. Survey of Canada.

Read before the American Association for the Promotion of Science.

THAT portion of the upper Silurian system of New York, which has been designated by the geologists of that state, the Onondaga Salt Group, is characterized not only by the saline springs to which it owes its name, but also by numerous deposits of gypsum and springs which are sour to the taste and contain free sulphuric acid. The one at Byron, New York, has long been known, and several others have been observed more recently in the same geological district. The same region in Canada affords a remarkable spring of this kind, which, in the course of my official duties, I had occasion to examine in the month of October, 1847. It is situated in the township of Tuscaróra, in the Indian Reserve, about twenty miles north of Port Dover, which is the nearest point on Lake Erie. The water contains a large amount of free sulphuric acid, about 4 parts in 1000, besides sulphates of the alkalies, lime, magnesia, aluminum and iron in small quantities. The proportion of these ingredients is however not constant, as is ev-

ident from an analysis made in April, 1846, by Prof. Croft of King's College, Toronto, which is confirmed by a partial examination by myself, of a specimen of water brought from the spring in June, 1845.

The specific gravity of the water was much lower, and the amount of foreign ingredients much less, than in that collected by myself, but the proportion of bases to the acid was much greater. The proportion of the lime to the acid I found to be about 1:15, and that of the magnesia 1:90, while Prof. Croft's determination gave about 1:6 and one to 1:15, respectively. That collected in 1845 is a nearly saturated solution of gypsum, while that of 1847 contains no more than about 7 parts in 10,000.

These facts indicate a rapid change in the constitution of the spring, and its situation shows it to be of comparatively recent origin; for although the powerful acid has destroyed all traces of vegetation for a distance of several yards around the source, the water issues from beneath the roots of an enormous pine-tree, whose half decayed stump still stands several feet in height, while the crumbling mould from its slow decay, forms the surface soil for some distance around. Without overlooking the antiseptic virtues of the mineral substances contained in this remarkable spring, this fact shows that its antiquity can scarcely be greater than a century, if indeed half that cycle may not extend beyond the time of its first development, while the rapid decrease in the quantity of the saline bases shows that its character remains constant scarcely for a twelve-month. It should have been observed that there are four or five basins within the distance of as many yards, and that they are situated on the summit of a low mound which rises with a gradual slope from the marshy plain.

The probable cause of these changes will be seen by adverting to the character of the gypsum deposits of this formation, which I regard as having an intimate connection with this class of springs. The investigations of Mr. Hall, in New York, and Mr. Murray, in Canada, unite in showing that the gypsum of these rocks always occurs in hillocks or dome-shaped masses, varying in size from one foot to 300 or 400 feet in diameter, and always near the surface of the formation. Sections of these masses show them resting upon undisturbed strata of limestone, while the superior strata are thrown up and rest upon the flanks of the intruded hillock, often very much broken, and, as Mr. Hall has remarked, in part consumed, so that one is at a loss to account for the disappearance of a large portion of the overlying strata. In one case observed by Mr. Murray, a slender cylinder of gypsum passes through several beds of the limestone, and at last terminates in a cone of the usual form, which is entirely superior to the limestone formation and surrounded by the tertiary clay of the region. The comparatively recent origin which this assigns to the gypsum

deposits, is confirmed by the common experience of the people of Western New York, where it is a well known fact that since the settlement of the country, walls have been disturbed and houses raised from their foundations by a gradual elevation of the surface, where subsequent examination has shown the presence of domes of gypsum.

On comparing these facts with those observed in connection with the acid spring, it appears probable that the origin of the gypsum is to be ascribed to the action of such mineral waters upon the calcareous strata. How far the pressure at a great depth may operate in preventing chemical changes, we may not know, but it is easy to see that once coming to a situation where it could act upon the limestone, it would evolve carbonic acid gas, and form a calcareous sulphate which from its sparing solubility would be at once deposited in a crystalline form, while the water would pass off saturated with the sulphate, and at the same time carrying with it the soluble sulphates of magnesia, alumina, and iron, which would be formed from the other bases, generally present in the limestones of this region. If the amount of acid were copious, or the supply of calcareous matter limited, the water might rise to the surface with free acid, as in the cases already noticed, and when the deposition of calcareous sulphate had extended so far as to protect the carbonate from farther action, the water would appear with a much smaller portion of bases than before, having only the sulphate of lime which it could dissolve from the sides of its channels.

If on the contrary, the acid were entirely neutralized, the spring would present at the surface the character of an ordinary bitter saline, containing calcareous and magnesian sulphates; two springs of this character are indeed found in the same formation not far from here. The ferruginous and argillaceous substance known as *gypsiferous marl*, which surrounds these deposits, seem to be due to the precipitation by the carbonate of lime of the iron and alumina, which have been previously taken up by the water yielding a mixture of these oxyds with carbonate and sulphate of lime. The fact that crystalline gypsum occupies nearly twice the space of an equivalent quantity of carbonate of lime, will at once explain the displacement of the superincumbent materials. The observation which is now required to confirm this theory, is to find the carbonic acid which should be evolved from the decomposition of the limestone, actually disengaged from one of these springs; the small quantity of gas which rises from the Tuscarora spring was found to be principally carburetted hydrogen, which is copiously evolved by the salines of this region, but it was collected at a time when from the minute portion of gypsum in the water, the action seems to have been at an end. I shall not attempt to speculate upon the probable source of the

sulphuric acid at present, but shall defer the consideration of the subject until the publication of my report on the mineral springs of Canada, which will be accompanied with the analyses of this water as collected in different years. Hoping that my observations may resolve a hitherto unexplained problem in the geology of this region, I beg leave to submit them to the notice of the Association.

ART. XV.—*On the Fundamental Principles of Mathematics*; by STEPHEN ALEXANDER, Professor of Mathematics and Astronomy in the College of New Jersey.

THE object of this dissertation is to present, to some extent at least, those ultimate principles and reasons, on which are founded the conclusions of mathematics; principles and reasons which lie beneath the artificial symbols which the science employs; i. e. —to borrow a most expressive and beautiful figure—an attempt will be made to seize upon and exhibit, in so far as may be, that "central thread of common sense, on which the pearls of analytical research are invariably strung."*

In pursuance of the object thus indicated, a definite arrangement will be made of the several topics to be specially considered, each under its own descriptive title; commencing with the following:

The Characteristics of Truth, especially Mathematical Truth.

(1.) *Truth*, which may be employed to designate the great object of all scientific research, is a term much too valuable to be misunderstood, but withal so general as not to admit of a ready definition. Yet, under its various aspects, truth will be found to present the characteristic feature of consistency with some great standard. Thus a careful consideration of its subjects of research will show that

That is *true* in *Mathematics*, which, under the existing system of things, is *supposable*. It is in no case requisite that the supposition should have been realized.

[No one, for instance, has ever seen a perfect circle; yet every one, who has carefully considered the matter, can clearly understand what a perfect circle ought to be, and will concede that its existence is entirely possible, perfectly *supposable*.†]

That is *true* in *Physics*, or (with some restrictions of application) in *Metaphysics*, which has been *permitted to exist*.

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* Sir J. F. W. Herschel—Cabinet Cyclopædia, Treatise on Astronomy, (10).

† Among the truths *supposable*, must even be classified those expressed by the aid of what are termed *imaginary quantities*.

[It *might be true*, in so far as we can discern, that heavy bodies should have been so constituted as in every case, to fall to the earth in an arc of a circle, or any other given curve. It *is a fact* that heavy bodies, falling freely, always fall to the earth in straight lines.

Glass might, perhaps, be so constituted under a new arrangement of things, that every known liquid would dissolve it; and this, without ceasing to be essentially what it now is. As things are now constituted, scarcely one or two of the known liquids will touch it.

In *Metaphysics*, moreover, one of the primary inquiries is not, whether it be *supposable* that man should be endowed with such faculties as reason, memory, &c.; but whether he *in fact* possesses them.]

Not to multiply examples, but recapitulating the characteristics already mentioned, we observe, that

That is *true* in *Mathematics*, which, under the existing system of things, is *supposable*—*That* is *true* in *Physics* and (with some restrictions) in *Metaphysics*, which has been *permitted to exist*.

That is *true*, in *matters of Taste*, which is *consistent with the laws of beauty* founded upon the *relations* of *things actual*—and *that* is true in *Morals* (in the highest and best sense, in which it is good);—*that* is *true*, in this sense, which is *consistent with what is to be found in the* GREAT SOURCE OF ALL GOOD. Or in general—due regard being had to its object—it may be asserted, that it is the *perfect consistency* with that which *may be*, or that which *is*, or that which *ought to be*, that constitutes the great characteristic feature of TRUTH.

Objects of Mathematical Research.

(2.) Mathematics, whether pure or mixed, has never to do with *things* as such, but only with the *relations of things*.

This is most manifestly true with regard to number, length, surface, capacity or volume, &c. For there are no such *things* as 2, 3, $7\frac{1}{2}$, &c., separately considered; nor can length, breadth, thickness, &c., exist apart from the things to which they belong, but only that *room* for them, which is to be found in space.

Thus also, mechanical force, motion or (in its qualified form) velocity, rest, time, &c., in so far as we have to do with them, exist not as *things*, but as the *relations of things actual;* and even the earth's orbit no where exists definitely in space; though, being a disturbed ellipse, of known dimensions, &c., it may be accurately prescribed.

(3.) Upon the fundamental fact, thus exhibited, depends the accuracy of mathematical reasoning. For, the relations of things with which it has to do, admit of being accurately ascertained and defined; which can by no means be always asserted of the

inherent properties of the things themselves; i. e., those which render the things to which they belong what they are.

For while the form, size, &c., of a body can in many cases be accurately ascertained, and the supposable mathematical form which that of the body may closely resemble, may have perfectly definite and well ascertained properties, we, as yet, can know very little of the atoms which compose that body, and cannot even assert that, in the strict sense of the word, it is composed of atoms at all.

It cannot then be a legitimate objection to the conclusions of mathematics, that there *are no such things*, as those to which they refer; since those conclusions have not to do with things as such, but with their *relations*, and as stated at the outset, (1.) it is sufficient that even these be *supposable*, constituted as things now are.

The Relations of Things are Matters of Constitution and Arrangement.

(4.) The relations of things already designated are themselves not mere figments of the human mind, but—as all experience teaches us—they are *constituted* relations: i. e., in so far as we have to do with them, their connexion with things actual is a matter of arrangement dependent upon the constitution of the things, or else the things themselves are in some measure constituted in subordination to those relations: or both.

Thus, one part of space is not diverse from another, nor does one day of the week of course succeed another, because we may *choose to think so*, but because the CREATOR has formed (or *con*formed) them so. For "of" HIM not merely are all things, but "by" HIM they also *consist:* or, in other words, HE has not merely made those things with which we are familiarly conversant, *what* they are, but also, in certain respects, *as* they are. Any similarity in the relations of things must therefore also be a matter of constitution or arrangement; and we may safely make use of it in the illustration of one class of relations, by a comparison with another.

Of Quantity and its Distinctions and Ratio.

(5.) *Quantity* is the general term employed to designate all those relations of things which are the subjects of investigation in mathematics. In so far as it is thus employed, it denotes whatsoever admits of the distinction of greater and less.

(6.) Two quantities are of *the same species*, if each, *in itself*, exceeds its less, in the self same respect in which the other, *in itself*, exceeds its less; i. e., the terms greater and less must be applicable, in the case of each, in the self same sense. They must, moreover, be thus applicable to the quantities themselves, and not merely to their boundaries or limits.

Thus a straight line and a curve are of the same species; since each exceeds its less in length—in which respect alone a line can be either great or small. But, a straight line and a square are of different species; since the one exceeds its less in length, while the other exceeds its less in surface; and this, although the boundaries or limits of the square are, themselves, straight lines.

A straight line and an hour are quantities of a different species, since the one exceeds its less in length, but the other exceeds *its* less (e. g., a minute) in duration.

(7.) So fundamental and inherent is the distinction between quantities of different species, that the combination of them by addition, or the attempt to subtract one from the other, or to compare what constitutes greatness in the one species with that which constitutes it in the other, will all be found to be impracticable, and even manifestly absurd.

Thus a straight line cannot be added to a day, nor a pound in weight be subtracted from the surface of a triangle; nor can we say of an hour and a square that one is larger than the other, or even compare them at all as to greatness.

The single point of resemblance between quantities of different species, is that indicated (5.) in the definition already given of quantity in general; viz., that the distinction of greater and less *in some sense*, is every where admissible. Hence it is possible to compare the ratio of two quantities of one species with that of two other quantities of another species; or even that an equality of such ratios should exist; one of the first pair being precisely as great or small in comparison with the other, in the peculiar sense of great or small which belongs to that species, as one of the other pair of quantities is great or small in comparison with the other, though in the peculiar sense of great or small which belongs to *that* species. Thus, 2 feet : 1 foot :: 2 hours : 1 hour.

Of the Limits of Various Quantities, and the Nature of Zero.

(8.) The nature of the boundaries or limits of the quantities of various species will next be considered; and this will naturally lead to an examination of the nature of *zero*.

The limits of bounded space being the most obvious, and also those with which we are most familiar, may well claim our attention first.

Solids, or rather volumes, *occupy* space; and their limits are surfaces. In accordance with what has already been advanced, (2.) it will be observed, that it is with the form, capacity, &c., of the space thus occupied, that the mathematician, as such, has to do, and not with the nature of the substance to which they may appertain.

A surface (i. e., the very outside) of a solid, although it bounds that solid, is yet no part of the solid itself. To remove or even

separately mark out any *portion* of the solid, the region at which the division is made or indicated, must lie beneath the surface. The surface exists only where the solid, or the space occupied by the solid, ends and other space begins. The surface itself occupies space not at all; it only *divides* space. It is not *somewhat*, in the same sense in which the solid is somewhat, but only *somewhere:* viz., where, as already stated, the solid ends, and space exterior to it begins.

The surface, then, having no capacity, is in that respect a *zero* of solidity; and we may with propriety say, when a solid such as a cube or a parallelopiped is reduced to its base (its altitude being reduced to *zero*), that the solid (as such) is reduced to *zero*.

The base or other surface, though thus a *zero* of capacity, is yet *somewhat* in its own sense—in the sense peculiar (6.) to that species of quantity—viz., *in superficial extent;* i. e., it still possesses, as it were, the property of covering or extending over, as well as limiting, a portion of the solid, and also that of *dividing* space.

But *a line* existing at the edge of such a surface, or any other, is not *somewhat*, even in the sense last mentioned, but only *somewhere:* viz., at the very edge of the surface. It does not *divide*, but only *penetrates* space.

If then a figure, such as a parallelogram or triangle, be reduced to its base (its altitude being reduced to *zero*), the surface of that figure will be reduced to *zero;* or the base having no surface, will be in that respect *zero; i. e., zero* of *surface*, or of area, which is measured surface.

A straight line whether it thus exist as the edge of a surface or be otherwise defined (e. g., the axis of a sphere), is yet *somewhat* in its own sense—in the sense peculiar to all lines—viz., in *length;* whereby, though it does not *divide*, it *penetrates* space.

A point, at the extremity of such a line, is not *somewhat* in *any sense*, but *only somewhere;* viz., at the very end of the line.

The like is true of a point, though otherwise situated; *e. g.*, at the centre of a sphere; where it is precisely at an equal distance from any and every point in the surface. This would cease to be true at any other position; though it were even at the smallest distance from the centre: so that this last cannot extend *somewhat* in any direction, nor yet be situated *any where else*, than in the position which has been already defined.

A point is thus the *absolute zero of space;* having "position, but not magnitude."

(9.) As in space there is room for the separate existence of all the material substances with which we are conversant, so, in duration, there is room, in a metaphorical sense, for the (successive) occurrence of events; and time is separated into portions, or has their termination marked by the limits of duration, as space is

divided or limited by its bounding or limiting surfaces; or as a line is divided into distinct portions or is terminated by a point. When the one analogy will be the more complete, and when the other, will the more distinctly appear, when the infinities of both space and duration are considered in their proper connection. It will however be observed, that a limit such as the midnight with which one day (according to the ordinary reckoning) ends, and another begins, is not *somewhat* in *duration*, but only *somewhere;* or rather—if such a word were admissible—*somewhen;* viz., *when* the one day ends and the other begins. A limit such as this is *an instant;* and its relations to duration, or to that measured or at least finite portion of it, which we call time, are analogous to the relations of point to space. An instant is the *absolute zero* of *duration*, as a point is the *absolute zero* of *space.* [An instant is different, therefore, from a *moment;* which is a small but indefinite *portion* of duration.]

(10.) Rest, is, in a manner sufficiently analogous, the *zero* of *motion;* and may exist as the effect of an equilibrium; which is rest compelled.

This *zero* occurs, when *and* where, the body comes to, or is found at, rest; or when *and* where, it is prevented from moving.

(11.) An *equilibrium* is itself one form of the *zero* of *force;* though *such* a *zero* may simply imply the absence of *all* force, from a given *place*, and at a given *time: when* and *where*, there is *no* force.

(12.) *Perfect shadow* is the *zero* of *light; whenever* and *wherever*, it may exist.

(13.) Lastly. Empty space is itself the *zero* of *matter;* however great that space may be in capacity.

(14.) In any and all of such cases as have been specified, *zero* implies the absence of *that to which it is related;* and point being no extent in space; an instant, no time; rest, no motion; &c. Yet, an instant seems to be almost as incomparable with a point, as an hour with a mile. Being related to quantities entirely unlike in kind, each alone has place (in its own peculiar sense of the term) in that species of quantity of which it is itself the *zero.*

A point, however, may have place in a line, which itself, as before shown, may be a *zero* of surface, and this surface, again, a *zero* of capacity; for the point, the line, the surface, and that which the surface limits, are all to be found in space itself. But the other *zeros* which have been specified, an instant, rest, equilibrium, shadow, and (with reference to matter) empty space, though any or all of them may exist *when*, if not *where*, and sometimes even, *when and where*, all the *zeros* already described are found, yet the presence or the absence of one will not, in every case, imply, or require the presence or the absence of another; and the relations of all, as well as those of other *zeros* will, when

carefully considered, lead to the conclusion, that *zero* is, in *no* case, to be regarded as the absence of *all quantity*—for then there could scarce be any occasion to consider it at all—but only as, in any case, *the absence of the quantity in question.*

[If then we should conclude, from considerations abundantly adequate, that before all that we here call somethings, there must have existed that which is not something; what we thus arrive at cannot be represented as a *zero*, except in the very respect that is *not something*, as the others are; but, even in so far as these considerations, thus exclusive, can determine, that which was before all these somethings may have been, and still may be *infinite* in its own way.]

Has Motion any place in Pure Mathematics?

(15.) What has already been said of a point, or the *absolute zero* of *space*, and rest, or the *absolute zero* of *motion*, may be found to have prepared the way for the consideration of the question:—how far, if at all, motion may be predicated of a *mathematical* point; or indeed, how far motion may have place, when what is to be moved, is a point, a line, a surface, &c., or any other quantity of those specially recognized by geometers.

Motion is *progressive* change of place. A body changes its place, as soon as it begins to move; *i. e.*, it *forsakes* the place which it occupied in space. It is transferred during the motion from place to place; and when the motion has ceased, the body is at rest; *i. e.*, no farther change of place occurs, but the body continues to occupy the place to which, at the end of the *progressive change*, it was transferred. The body itself was thus transferred, and not the place occupied by it: and all the boundaries, limits, or points situated in or about that space would be found to retain their positions, upon a reference to fixed standards. Neither space, then, nor the limits of it, are found to be the subjects of motion; that being, in so far as we can investigate it, a *physical* property of body, or, at most, of that which is in any sense connected with a body; as in the example of our own selves.

Yet a point, under certain circumstances, is, *as it were*, transferred along a line.

Thus when a pyramid so moves as to change the position of its vertex, the *mathematical* point at that vertex, is successively to be found at different places in the line which marks the limit of the whole space, either occupied, or passed through by the solid.

It should, however, be borne in mind, that a *mathematical* point, as already described, (8.) is not somewhat *in any sense*, but *only somewhere;* and the *place* of the point, in this instance, is precisely where the *pyramid ceases to be found at all*, and ex-

terior space begins. Now as the pyramid, during its motion, continually *forsakes* the place it may happen at any instant to occupy, the point at the vertex being just *without* the pyramid, or at the limit of the space thus occupied, will be at once *left behind;* the motion by hypothesis being such that the vertex should not be stationary; i. e., the particular cases of a rotation about the vertex, without a progression from its position in space, being excluded. That the *mathematical* point at the vertex will be thus *left behind* or forsaken, will moreover appear, incontrovertibly, from the fact that its position as determined by fixed standards of reference will be found to be invariable.

It is nevertheless true, that the line in which, or precisely *at* which, the vertex, during the motion, is always found, will be distinctly marked out; it being the limit *up* to which that space extends, which was either occupied or passed through by the pyramid.

The like must be true of the centre of gravity of a sphere in motion through space, or which has so moved. A *new* point in space will be found to be the position of the centre of gravity, as the sphere advances. Still more obviously must the like be true of the centre of gravity of two or more bodies, when they so move as to change its position, that centre moreover being throughout supposed to be without the bodies themselves. When the masses, &c., of the bodies are known, the successive positions of the centre of gravity of two or more may be computed, or even prescribed; yet such a mere position, at any instant in space, is not *pushed* forward or *drawn* backward by or with those bodies; and all this, while, moreover, the entire curve in which all the successive (but certainly *different*) positions of the centre of gravity are situated, may throughout admit of being accurately defined, and its limits therefore precisely settled. Indeed, lastly, should we suppose the contrary to all this to be true, we could not escape from the seeming contradiction, that a point which (8.) is the *absolute zero* of space should become *somewhat* in space, that is, should be drawn out into a line which has length, by the introduction of the *foreign* element of motion.

We must, in view of all that has been advanced, regard the motion of a *mathematical* point, as a pleasant fiction; the result as regards position, magnitude, and of the quantities concerned, being the same as it would be if such motion were possible; while the actual description of a *mathematical* line in space would require the motion of *a pointed atom*, if such a thing may be.*

* This does not militate against the *mathematical* existence (1.) of such curves as the cycloid, &c.; since it is only necessary to suppose the generating circle, or other curve, &c., to be drawn on *a material substance;* that it take successively the several positions required; and that the point at the edge, or elsewhere, be assumed successively where the describing point ought to be.

This fiction may not however be wholly harmless, when not merely *mathematical*, but also physical relations are the subjects of investigation. Such is the case in mechanics, when motion becomes the subject of investigation as a *physical* property, as which alone, in accordance with what has already been said, is it in any case (in effect) to be regarded. The motion of a body involves then the motion of its atoms, and as there can be no moving *mathematical* point, a moving point, or whatever in mechanics may be spoken of as such, must be a *moving atom*. Its physical property of motion, the laws which regulate it, and those which determine an equilibrium, must be made to rest upon observation, experiment and induction.*

Corollary.—There can be no "*Rational Mechanics*," in the sense in which that phrase is often employed.

The considerations already urged, against the doctrine of the motion of a *mathematical* point, will apply with equal force to the case of a *mathematical* line, surface, or solid.

Fundamental Reason for the Existence of Incommensurability.

(16.) From the consideration of limits, zeros, and their special relations, we may pass to that which supposes the introduction of new limits; viz., the division of quantities into parts or portions; fractions, properly so called, among the rest; by the aid of which, the nature of incommensurable quantities and the necessity for their existence may both be made apparent.

If we select as a very simple example, a finite straight line; and suppose it to be divided in the middle, into its two most simple fractions; viz., its two halves; each half will, of course, be equal to the other. When we divide the same line into thirds, three fractions will be obtained, all equal among themselves. The same perfect equality of the parts will still be found when we successively divide the line into fourths, fifths, &c.; any one of such fractions being an *aliquot* part of the whole; and any fraction, such as $\frac{3}{4}$, $\frac{5}{6}$, &c. of the line, a combination, or grouping together, of such *aliquot* parts.

Now, however many such divisions of the whole into all the several fractions of the series of halves, thirds, &c., may be made, it must happen, if the process be far enough continued, that some of the points of division will agree, ($\frac{3}{4}$ of the whole being equivalent to $\frac{9}{12}$ of the same, &c., &c.;) and there no new division of the line will take place. Yet some must also differ, at each new division; since $\frac{1}{2}$ cannot $= \frac{1}{3}$, nor $\frac{1}{3} = \frac{1}{4}$, &c.; and very many other combinations, such as $\frac{2}{3}$, $\frac{3}{4}$, &c., must be different, as the

* The French phrase, "un point matériel," is descriptive of the real state of the case; whatever may be said of the reasoning in connection with which that phrase may sometimes occur.

theory of numbers would indicate. ***However many divisions*** into ***aliquot parts*** may then be effected, there always must be positions on the line, included between the points of division so obtained; since no two of the successive divisions of the whole line can agree, as has already been shown, at ***all*** points. In other words, there must exist positions between the points of division so obtained, which no division of the line into fractions, (i. e., ***aliquot*** parts or their aggregates,) ***however numerous***, can ever mark. At any or all such positions, the line would be divided into two parts ***incommensurable with the whole***, and of course ***incommensurable with each other.***

The combination, by addition, of the original line or unit and a line equivalent to such a portion, would be of a length which may be represented as between 1 and 2 such units, but the excess above 1, such as cannot be expressed by any fraction, &c., &c.

The like principles must be applicable to the case of any other quantity which will admit of the like successive fractional division.

The fundamental reason for the existence of incommensurable quantities seems, then, to be, more concisely, this: The division into fractions is a division into ***aliquot*** portions, or implies such a division of the whole as the aggregate of such portions would furnish. Now this is so far from being the only mode of originally dividing the quantity, that it must be regarded as a peculiar and restricted one; in so much that it would almost seem that the result of a fractional division is not that which would most probably be obtained, if the quantity were divided at hazard; or the chances would be more numerous, that the quantity would be divided incommensurably, than that it would be divided into fractions properly so called.

(*To be continued.*)

ART. XVI.—*Notes on the Geology of Charleston, S. C.;* by F. S. HOLMES, Corresponding Member of the Acad. of Nat. Sciences, Philadelphia.

THAT Charleston, the Capital of South Carolina, is built upon geological formations identical in age, and in other respects similar to those upon which the great cities of London and Paris are located, is a curious fact but lately ascertained. The basin shaped depression of its underlying calcareous and other beds, as determined in the survey just made by Professor Tuomey, occupies a considerable extent between the Savannah and Peedee Rivers, and rests upon an older group of rocks known to geologists as the Cretaceous formation. The sides of this basin are estimated to be of sufficient inclination to produce those artificial fountains,

which are procured by boring, and known as "Artesian Wells," through which by hydrostatic pressure, the water is forced up to, if not above the surface.

This basin seems destined to become as famous in the eyes of the scientific world as that of Paris, from the number of new and interesting fossil remains with which it abounds, while those of them already exhumed claim for it a rank above that of the London basin.

The tongue of land upon which Charleston is built, was originally a flat peninsula, having Ashley River on the West, and Cooper on the East; these uniting to the south of the city form the bay and harbor, which discharge their waters into the ocean about six miles below. There were five creeks which emptied into Ashley, four into Cooper, and but one at the point of the peninsula. These have all been for the most part filled up and built upon; and the few slight ridges of yellow sands which extended from river to river in lines from N.E. to S.W., parallel to that of the sea coast of this state, have been leveled for the same purpose. Strikingly developed in the Sea Islands, these ridges are a characteristic feature of the lands bordering upon the ocean, and are known as the yellow sand hills, which produce the fine long cottons in such perfection. In appearance they resemble the ground swell of the ocean observable on our coast when the wind is from the east. And it is to this ground swell that I am disposed to attribute their formation; and not entirely to the drift sands which compose the dunes or small islands found between them and the ocean, and skirting nearly all the sea islands.

The sands of the dunes are white or grey, whilst these are yellow, being colored by a slight mixture of yellow clay; the dunes are irregular, lying in every direction; these form long parallel ridges with valleys, which have been denuded of their coverings by the action of the currents and easterly winds alluded to above.

As you approach the coast the hills are highest, and they gradually lessen as you recede towards the main land, which is generally level except immediately upon the creeks and rivers. Sometimes these ridges are found slightly developed upon the main, where the land is open to the sea; but they are as inconsiderable there as those which existed in Charleston. As the gray sands do not produce the long cottons in perfection in adverse seasons, the plantations of the interior and inner sides of the islands, and those also of the main land are considered much less valuable. The formation of these ridges must have occurred when the land was gradually emerging from the sea. The dunes which compose the small belts skirting most of the Sea Islands, serve as barriers for the protection of the latter from the advances of the

ocean, and are separated from them by narrow creeks often with flats and salt marshes on their sides.

Several of the Sea Islands have no such separate barrier, but the sand hills or dunes lie along their ocean side.

It is generally supposed that the sea is rapidly advancing upon our shores, from the fact of these belts having become narrower, and because in some places along the line of coast the sea has encroached considerably; but from several observations made at different times and under favorable circumstances, I am convinced that this is not generally the case, but that if the ocean does wash off portions of the shore at one exposed point, it deposits the same at no great distance upon another. Let us take for example the islands at the entrance of Stono Inlet. Look at the old maps, and you will find that the southernmost point of Bird Key, (a cluster of dunes sometimes called Brown's Bank,) formerly lay some distance within the line of coast formed by Folly Island on the N.E. and Kiawah on the S.W., and had a considerable bay or inlet between the breakers and its south side, while the channel or principal entrance to Stono River passed between it and Kiawah Island. Compare this state of things with the situation of the Key at the present day. The north side now corresponds with the south line of coast of the two islands, Folly and Kiawah; the main channel passes between Folly Island and the Key on the opposite side to where it formerly was, and the principal bay is on the north instead of the south.

But let us consider the causes of these changes. From three several visits in as many consecutive years, made for the express purpose of observing and recording the modifications and changes which have been, and are still in progress at this interesting point of our coast, I infer that the principal agent in their production has been and still continues to be the current of the ebb tide of Stono River. This stream just before its entrance into the bay, receives the waters of Kiawah River, which, contributing greatly to its force, undermine and carry off the sands from the north side of the Key, and gradually increase the depth and width of the passage between it and Folly Island. This channel is now the most direct course of the river to the ocean, but formerly having been greatly obstructed by the north end of the key, the current was, in consequence, turned aside and passed around the point of Kiawah. A portion of the sands thus removed, have been deposited on the south point of the Key, again to be cast up by the surf and formed into hills or dunes by the prevailing sea breeze, and the rest have been added to the immense banks now in course of formation to the south of Kiawah Island, extending from its beach out to sea for one or two miles, and in length about three. Those banks are now entirely covered at high water; but a few years only will suffice, at the

present rate of increase, to raise them entirely above the level of the ocean.

Another important agent in producing the modifications under consideration is the prevailing easterly winds, disposing these sands to be ever shifting from the windward to the leeward, and causing them to move despite all opposition, at a steady though almost imperceptible rate.

At my second visit to the Inlet in the summer of 1846, I observed that a fragment of a ship stranded upon its bar (part of the hood or poop-deck, painted green) had drifted in at high tide and lodged on the Key to the leeward of one of these dunes, the base of which was about thirty feet wide, and at the time I first saw it was being rapidly covered by sands blown over from the windward or ocean side.

On my second visit in the spring of the following year, I found about three feet of one of the planks of this fragment protruding from the opposite side, the hill or dune having nearly passed over it. How much remained covered, I had no means of ascertaining; the fishermen who frequent the island, had cut up and used the exposed part as fire-wood, thus destroying the ends by which alone I could have formed an estimate. The planks, with the single exception mentioned, were cut even with the sands; and as I had no suitable implement for the removal of the latter, I had to content myself with a superficial examination.

A similar incident was related to Professor Tuomey and myself, when we visited this neighborhood together. A raft of boards had drifted upon the inner side of Kiawah point, and lodged on the flat at the foot of one of these hills, by which it was soon covered, and after the lapse of some time, the length of which was not remembered, it was seen to protrude from the opposite side.

The surf has made considerable breaches in the islands of Folly, Coles and Kiawah, to the enlargement of which the waters from the creeks in the rear of the two last named have contributed in no slight degree. But the sands from these have only been removed, to contribute to the formation of the large bank, to which I have already alluded.

Let us now resume the examination of the formation underlying the city of Charleston, as developed by the auger used in boring the artesian well, and also as exposed in the creeks and rivers of the vicinity. Beneath the ridges of yellow sand which have been described, is a stratum of red ochreous clay, provincially termed by the planters, "iron-ore clay," which covers another of white and grey sands, that are sometimes found also between the clay and the yellow sand above. From these strata, which seldom extend twenty feet below the surface of the city, is the "pump-water" obtained. To define the line of separation

between the alluvium and diluvium, (if both are here,) I shall not attempt, but leave it to more skillful hands, with a single remark.

At Ashley ferry, ten miles N.W. of Charleston, the stratum of red, or "iron-ore clay," with its thin seam of grey sand, is exposed in a section of the river bank, resting immediately upon the Eocene marl, while under the city a bed of Post-pliocene intervenes. I infer this to be the same as the deposit of clay in Georgia, of which Mr. Lyell speaks, and from which he obtained the grinder of the mastodon, and Dr. Habersham bones of that and other extinct mammalia. Mr. Lyell represents it as "resting immediately on sand containing marine shells of living species," which sand, I should infer, corresponds with the Post-pliocene bed of South Carolina.

I have never found any teeth or bones in this clay, but fragments of the grinders of the mastodon, with gravel and drift from the river lodged in the holes of the surface of the Eocene marl exposed in the bed of the river, have often been found by myself and friends, and it is quite reasonable to infer that they were washed out of the clay by the current. Some years ago I found portions of a large bone which I supposed to be a femur of a mastodon or other large mammalian, in a cavity on the surface of a Post-pliocene bed, with the clay immediately above it. These specimens are now in my cabinet.

The next in the order of descent is the blue mud and sands, with shells of the Post-pliocene formation, to which allusion has just been casually made. This is the newest of the tertiary; sometimes the blue mud is missing, and laminated sands and clays are mixed with or cover the beds of shells.

The testacea of this bed, whose analogues are supposed by Mr. Lyell and some other geologists, to be those now living in the neighboring waters, lie in patches filling the depressions and irregularities of the surface of the Eocene marl, upon which they are *always* found immediately to rest. I say *always*, because I have never seen the Miocene underlying the Post-pliocene in the order of superposition, but in every exposure that I have examined, the Eocene has been so found.

The two Miocene deposits near Charleston, are covered either with diluvial sands, or the alluvium of the rivers; whence I infer, that during the deposition of the Post-pliocene, these patches of Miocene must have been above water, or were denuded of their Post-pliocene covering previous to the deposition of the diluvial or alluvial sands and clays.

With but a single exception, the Post-pliocene is never above the level of high water. In a well dug on the side of a run, about a quarter of a mile inland from Ashley ferry, and ten miles N.W. of Charleston, shells of this formation have been exposed. I accompanied Professor Tuomey, late state geologist, in the ex-

amination of this deposit, and assisted him in taking its level. As there was much water in the well, this point could not be accurately determined; but it was estimated to be at least three feet above high water mark.

The low country of South Carolina is well watered by a number of bold streams, which for the most part, are connected a few miles above their mouths by creeks passing between the sea islands of the coast and the main land, providing a safe and continuous inland passage for steamboats and small craft, from Georgetown to Savannah. In one of these passages, the most extensive exposure of the Post-pliocene and its superimposed diluvium or alluvium may be seen at the plantation of William Simmons, Esq., on Yonge's Island, about twenty-five miles S.W. of Charleston; it is separated from Wadmalaw Island by the river of the same name, (sometimes called "the Sound,") which also unites the waters of the Edisto and Stono rivers. The rapid current which sets in upon the bluff of Yonge's Island, sweeps off with every southeasterly gale, portions of this noble bluff, carrying with it the cotton plants that grow in the field above, the level of which is about twenty-two feet in its highest part from the surface of the shell bed forming the beach at its base.

Most of the shells in this bed are in a perfect state of preservation, and when denuded as they are for a great extent, of their covering of sand and clay, are seen in clusters of a dozen or more, each species forming a little colony or family, occupying the positions in which they lived and died. The adaptation of the mud in which they are imbedded, and which is so suitable to the habits of the testacea, is beautifully exemplified by the fact of recent species taking up their abode in it; and hence the difficulty sometimes, of determining the recent from the fossil of the same species; the dead shells of the former being often found in the same patches with the latter.

The first specimen of Pholas costata discovered, was put down in our catalogue of fossil species, and it was not until many visits had been made, and the bed dug up one or two feet, that the living ones were found. Two species of Pholas, (P. costata and P. truncata,) with Petricola pholadiformis, are abundant. Occasional specimens of Pholas oblongata are also to be had. Thus we were obliged to discard many fine specimens as recent, which had been preserved as fossil. The living Ranella caudata, Venus mercenaria, and Cultellus caribœus, have also been found at this locality.

The characteristics of the Post-pliocene testacea, are supposed by Professor Agassiz, who examined cursorily a few of the most prominent specimens in my collection, to be indicative of specific differences from those of similar forms now inhabiting the waters of the coast. I acknowledge my obligations to this gentleman,

for pointing out discrepancies which hitherto had escaped observation, but which the microscopic eye of the "Neufchatellian Naturalist" at once discovered. The splendid Mellita, the admiration of all who have seen it, resembles in its external form the recent Mellita (Scutella, *Lam.*) quinquefora of the coast, and has always been considered identical. The latter has never been found over five, or perhaps four and a half inches in diameter. I have never seen one so large; they seldom exceed three and a half inches on this coast; whereas this fossil will average eight inches. Many are found of nine, but not one less than five inches in diameter, and of this last size few are to be had. At the suggestion of Prof. Agassiz, I will call it *Mellita ampla*, it being the largest known of any species in the world, and shall describe it, with its characteristic differences, in the Journal of the Academy of Natural Sciences, of Philadelphia, together with other new shells from the beds of the Charleston basin.

The following catalogue contains one hundred and forty-seven species of Post-pliocene fossils now in my collection, and that of my friend, Dr. Thos. L. Burden. They were all of them obtained from the exposures of Yonge's Island; Abbapoola creek and Ratlin's bridge, John's Island; Submarine bed, Stono river; John Hamblin's, Esq., Christ Church Parish; and at the plantations of A. H. Brown, Esq., Old Town Creek, and Joseph F. Bee, Esq., Ashley Ferry, St. Andrew's Parish.

POST-PLIOCENE FOSSILS OF SOUTH CAROLINA.

1.	Dentalium politum.		
2.	Spirorbis sps.?		
3.	Teredo navalis,		Lam.
4.	Serpula.		
5.	Coronula dentulata,		Say.
6.	Balanus ovularis,		Lam.
7.	Pholas costata,		Lin.
8.	P. oblongata,		Say.
9.	P. cuneiformis,		Say.
10.	P. truncata,		Say.
11.	Solen ensis,		Lin.
12.	S. viridis,		Say.
13.	Solecurtus caribœus,		Lam.
14.	Lutraria canaliculata,		Say.
15.	L. lineata,		Say.
16.	Cumingia tellinoides,		Conrad.
17.	Crassatella, sps.?		
18.	Mactra lateralis,		Say.
19.	M. similis,		Say.
20.	Mya arenaria,		Lin.
21.	Gnathodon cuneatum,		Gray.
22.	Amphidesma equalis,		Say.
23.	Sanguinolaria fusca,		Say.
24.	Pandora trilineata,		Say.
25.	Petricola pholadiformis,		Lam.
26.	Tellina alternata,		Say.
27.	Tellina polita,		Say.
28.	T. brevifrons,		Say.
29.	T. flexuosa,		Say.
30.	T. lusoria.		
31.	Corbula contracta,		Say.
32.	Lucina punctulata,		Lea.
33.	L. crenulata.		
34.	L. divaricata,		Lin.
35.	L. trilineata.		
36.	L. sps.?		
37.	Astarte lunulata,		Con.
38.	A. sps.?		
39.	Cyrena carolinensis,		Say.
40.	Donax variabilis,		Say.
41.	D. fossor?		Say.
42.	Byssomia?		
43.	Cytherea Sayana.		
44.	C. gigantea,		Lam.
45.	C. obovata.		
46.	Artemis concentrica,		Born.
47.	Venus mercenaria,		Lin.
48.	V. permagnum.		
49.	V. cancellata,		Lin.
50.	V. elevata,		Say.
51.	Cardium muricatum,		Lin.
52.	C. Mortoni,		Con.

53. Cardium ventricosum, Brug.
54. C. isocardium, Lin.
55. C. marmoreum, Lam.
56. Cardita tridentata, Say.
57. Hiatella stonoensis.*
58. Arca transversa, Say.
59. A. incongrua, Say.
60. A. pexata, Say.
61. A. ponderosa, Say.
62. A. lienosa.
63. A. cælata.
64. A. Buckleyii.
65. Pectunculus glycimeris.
66. Chama congregata.
67. Nucula limatula, Say.
68. N. acuta, Con.
69. N. proxima, Say.
70. Pinna seminuda, Lam.
71. P. muricatum, Lin.
72. Pecten dislocatus, Say.
73. Lima, sps.?
74. Avicula atlantica, Lam.
75. Mytilus lateralis, Say.
76. Ostrea fundata, Say.
77. O. equestris, Say.
78. O. virginiana, List.
79. O. wadmalawensis.*
80. Anomia ephippium, Lin.
81. Plicatula ramosa, Lam.
82. P. cristata.
83. Hyalea Tuomeyi.*
84. Fissurella alternata. Say.
85. Infundibulum centralis.
86. Crepidula fornicata, Lin.
87. C. depressa, Say.
88. C. plana, Say.
89. C. convexa, Say.
90. C. cornucopia, Lea.
91. C. aculeata, Gm.
92. Bullina canaliculata, Say.
93. Auricula bidentata, Say.
94. Eulima, sps.?
95. Natica duplicata, Say.
96. N. heros, Say.
97. Acteon?
98. Sigaretus perspectivus, Say.
99. Columbella avara, Say.
100. Columbella, sps.?
101. Planorbis trivolvis, Say.
102. Pyramidella suturalis, Lea.
103. Pasithea eburnea, Lea.
104. P. exarata, Lea.
105. Scalaria clathrus, Lin.
106. S. lineata, Say.
107. S. angulata, Say.
108. S. multistriata, Say.
109. Cancellaria reticulata, Lin.
110. Oliva literata, Lam.
111. O. mutica, Say.
112. Littorina irrorata, Say.
113. Nassa obsoleta, Say.
114. N. vibex, Say.
115. N. trivittata, Say.
116. Buccinum acutum, Say.
117. B. lunatum, Say.
118. B. sps.?
119. Marginella limatula.
120. Cerithium dislocatum, Say.
121. C. monoliferum, Lea.
122. C. sps.?
123. Pyrula carica, Lam.
124. P. perversa, Lin.
125. P. canaliculata, Lin.
126. P. pyrum, Dill.
127. Fusus cinereus, Say.
128. Fasciolaria distans, Lam.
129. F. (Trapezium) gigantea, Kiener.
130. Ranella caudata, Say.
131. Strombus pugilis. Lin.
132. Delphinula, sps.?
133. Ovula acicularis, Lam.
134. Rotella.
135. Trochus philanthropus, Con.
136. Nodosaria.
137. Echinus punctulatus, Lam.
138. Spatangus atropus, Lam.
139. Mellita ampla.*
140. Astrea, sps.?
141. Alveolites glomerans.
142. Lunulites denticulata.
143. Teeth of Carcharodon.
144. " " Lamna.
145. " " Notadanus.
146. Palatal bones of Myliobatis.
147. Crabs' claws are also numerous.

The Strombus pugilis, No. 131, is not known to me as an inhabitant of these waters, but it is abundant in the Floridian and West Indian seas; and the only locality from which the beautiful Astarte, (No. 38,) has been obtained in a living state, is on the coast of California. It would, therefore, appear that the climate

* Not yet described.

of South Carolina has changed, and the waters of the coast become too cold and uncongenial to these testacea, if, as some suppose, they are of the same species.

Other interesting geological phenomena are displayed in this inland passage of Wadmalaw Sound, which demand some notice. Beginning at Bears Bluff on the west, where it connects with the Edisto river, and ending at Wappoo cut, on Stono river, to the east, there is no portion of it that does not impress upon the mind of the most careless observer, the conviction that it was once an extensive fresh-water swamp. Stumps and logs of the largest cypress and cedar trees (*Cupressus disticha* and *Juniperus virginiana*) are met with, throughout its extent. There are persons now living, who remember when parts of this passage could only be navigated by canoes, where now some half dozen steamboats could lie abreast, and where there is water sufficient to float a frigate. Throughout its extent, but principally about midway of this passage, its navigation is greatly obstructed by mud-flats, which are exposed at half-tide, and can only be passed by vessels of light draft, and at high water. The salt marshes extend from the river to the high land on both sides, and vary from a few yards to a mile in width; and their surface is slightly covered by every tide.

But the most interesting feature is the hundreds of little "cedar islands," as they are called, whose soil, composed of vegetable matter, partly decomposed, is only one foot deep, and rests upon the mud on which grows the salt marsh. The spring tides flow over them, but the ordinary tides, rising only above the marsh land, surround and undermine the small cedars found growing there in great numbers, whose lateral roots being confined to a light superficial loam, the stunted trees are compelled to yield to the destructive agent, so that the whole space is filled with their living and dead, or dying trunks. The larger ones with tap-roots descending deeper than the superficial loam, remain erect after death; but there are hundreds that are prostrated often whilst alive, and that lie just where they fell, with their trunks directed outwards. These, as soon as their small limbs and sappy parts have rotted, become imbedded in the salt mud; and the islands on which they stood being eventually deprived of their covering of vegetable loam, a growth of salt marsh speedily springs up.

Undoubtedly these islands were once occupied by the large cypress trees, whose trunks and stumps (many of the latter erect) are now found in numbers in the soft mud around. When the barriers to the ingress of the salt waters of the Edisto and Stono rivers were originally destroyed, they did not immediately cover the whole of the swamp in question; but after providing a channel for themselves, they must at the return of every tide have gradually increased in width, and thus carried off more or less of

the superficial vegetable deposit in the manner already described. The large trees having their tap-roots below the loam, were first killed, and many of them being exposed for a long time as erect dead trunks, were broken off by gales, which left the stumps in the position in which we now find them. The mud below becoming very soft, permitted these to sink into it and become imbedded, leaving the peaty loam above them in the possession of small cedars, the former undergrowth of the swamp.

May not many of the instances to be met with along the seaboard, and which have been cited by geologists as cases of subsidence, be referred to the operation of similar causes?

Off the beach at Coles Island, about one hundred yards from shore, are several stumps of oak trees, erect, surrounded by beds of oysters (O. virginiana) and only exposed at low water. Among them is one trunk of a live oak, (Quercus virens,) about eight feet high, over the top of which the tide at its highest does not rise, presenting a most singular, but interesting sight, when the heavy surf at high water is rolling around it. On a calm day, during one of my visits to this spot, I moored my boat to it whilst making observations in the survey of the inlet.

Next in order as we descend below the Post-pliocene, under the city of Charleston, is the Eocene, or lower Tertiary; the first stratum being an olive-colored peaty substance, resting upon another of sand, that separates it from the great marl-bed below. This stratum of sand contains a quantity of water, which, in the boring of the Artesian well, rose in the tubes to within six feet of the surface, and greatly obstructed the progress of the auger by filling it with quicksand.

Imbedded in the peaty substance before mentioned, are numbers of rolled and water-worn rocks of all sizes, from a few inches to a foot in diameter; a fresh fracture in any of which discloses the same forms of fossils as are seen in the great marl-bed below, of which, no doubt, these are fragments, broken off by the action of the sea, and rolled into bowlder-like masses; their nature changed by some chemical process, whereby nearly all the lime has been extracted, and the casts of the shells are left preserved in a silicious rock, emitting when broken a fœtid odor. The causes which produced the separation of these fragments, and the subsequent deposit of them in a distinct stratum one foot thick, are yet undetermined. The fragments are much larger where they crop out on the surface, ten miles north of the city, than they are in the part of the basin immediately beneath it.

These strata, including the first ten feet of the underlying marl, may be properly called the "Zeuglodon" or "Basilosaurus" bed of the "Charleston basin," which Professor Agassiz has pronounced "the richest cemetery of animal remains that he had ever

seen." From it was taken the most perfect skull yet found of that wonderful gigantic fossil cetacean; and by which was determined the true character of this singular animal.

Isolated teeth and bones of Basilosaurus, Dinotherium, Megatherium, Equus, and nearly fifty species of sharks, are obtained in abundance, as are also bones of a large Chelonia. I have in my cabinet three links of the vertebræ of Mosasaurus, "the great animal of Maestricht," a cretaceous fossil which I obtained in the marl of Ashley river. The number of undetermined teeth and bones is considerable. Two specimens of walnuts, with the epidermis converted into lignite; three casts of hickory-nuts, very perfect and beautiful, and fragments of wood, (now lignite,) bored by the Teredo, whose casts in marl are yet preserved, have been also obtained; and at every visit something new is added to my stock.

Few shells are preserved in a perfect state, but casts in the marl of many genera and species are easily obtained in the upper beds. Of the perfect specimens, "Balanus peregrinus" *Morton*, "Gryphæa mutabilis" *Morton*, Anomia rugosa, and Scalaria Sillimani *Morton*, may be said to be abundant; whilst one hundred specimens of a species of coral, (Anthophyllum atlanticum, *Morton*,) can be obtained from a cubic foot of this marl: it is the most abundant fossil of the Ashley bed.

There is one other class of fossils characterizing the marls of Ashley and Cooper rivers, which, though of the most diminutive forms, are no less wonderful or interesting; I allude to the Polythalamia, (composed of many cells,) beautiful little shells, which are generally microscopic; but many species of several genera, sufficiently large to be examined by the naked eye, are quite common. My cabinet contains a fine suite which I collected from the borings of the Artesian well. The matrix inclosing these shells is, itself, a mass of Infusoriæ.

Professor Bailey, of West Point, (to whom I sent specimens for examination,) writes me that he has placed a good supply of the Charleston marl in the hands of Ehrenberg, and requested him to determine the species, which labor he has undertaken; but his results are not yet published. Of those which I sent Professor B., many were destroyed before reaching him; among the remainder he distinguished forms of the following genera: Robulina, Cristellaria, Dentalina and Nodosari. "These," says he, "are *giant* specimens of their kind, being vastly larger than the forms which I had previously studied in the marls of the wells in your city."

The fossil, mineral and other characters of the marl of Ashley and Cooper rivers, differ considerably from those of the Santee beds belonging to the same formation, which out-crop at various points between those rivers and the Santee. The fossils too of the first do not indicate as great an age as those of the last, and no green sand nor extensive veins of water have yet been found

in the Ashley and Cooper river marls, though this fluid oozes slowly and in small quantities through every part of them.

The most wonderful feature of this older bed is the number of subterranean streams of fresh water by which it is traversed. The surface of the Santee region abounds with funnel-like depressions, called lime-sinks; caused, apparently, by the falling in of the marl and superincumbent soil, which had become too thin to support its own weight, from the washings of the stream beneath. Instances have been known of the ploughman, with his team, being engulfed by the sudden falling in of one of these lime-sinks.

During the spring of the present year, the swamps having been dried up, and the rivers reduced to a very low state, from the drought which had prevailed all winter, I availed myself of the opportunity thus afforded of examining the exposures of marl on the water-courses of this region, and also some of its beautiful springs, or subterranean streams.

Woodboo, a plantation belonging to the estate of the late Stephen Mazyck, Esq., is remarkable for two springs, the vent of one or perhaps two of these subterranean streams. The waters flow from openings in the marl, four or five feet in diameter, at the bottom of a basin, the area of which is several hundred feet; and so beautifully clear and transparent are they, that the trout, bream, and other fish, and indeed objects of the smallest size, may be distinctly seen at the depth of twenty or thirty feet. The bluish tinge of the water, too, casts a sombre, but agreeable hue on all around; and the general effect is not a little enhanced by the willows and cypresses extending their graceful arms above its surface, and studding the banks of a considerable stream which, flowing from the basin in a winding course, empties, at the distance of nearly half a mile, into the Santee Canal, the lower sections of which are dependent upon it for their supply of water.

An incident was related to me in connection with these springs, which will convey some idea of the extent of the subterranean streams of this region, and which, extraordinary as it may appear, a similar and subsequent event, coming within my own observation, leaves me no ground for doubt. I will first relate the one which I witnessed.

Before reaching Black Oak Lock, I was informed that there was a "break" in the canal at this point, by which all the water from one section had escaped, so as to overflow completely a swamp at a short distance from it, where, owing to the drought, no water had lain for some months previous. Supposing that the "break" in question had occurred in the bank of the canal, and that if large enough to permit the escape of the waters of an entire section, it would expose much of the material composing the embankment, I thought myself fortunate in getting such an

opportunity to view the exposed bed, and collect fossils from the mass constituting its margin. But my surprise may be imagined on arriving at the spot, to find a number of workmen surrounding a large hole, or sink, in the *bottom* of the canal, and to learn that that was the "break" by which the waters had escaped. This was produced in the same manner, and was in fact nothing more than a lime-sink, such as I have already described.

Still more singular were the circumstances related to me respecting the Woodboo Springs. Many years ago, a similar "break" or sink having occurred in the canal, it was repaired by driving piles into it, and filling the interstices with fascines made of rice-straw, (then grown extensively in the inland swamps of this neighborhood,) covering these with rammed clay, and planking over the whole. The work, however, having been carelessly performed, did not last long; the piles, fascines, and other material used in the repair, suddenly disappeared, and were followed by the waters of that entire section of the canal. Two months afterwards, to the surprise of those who witnessed it, the fascines of rice-straw came up with the bubbling waters of Woodboo Springs, at a distance of two miles below.

Since writing the foregoing, I have received a letter from Dr. Edmund Ravenel, written, as he therein tells me, upon seeing my report to the city council of Charleston, of a water-bearing stratum penetrated in boring the Artesian well. Coming from one who has lived many years in the neighborhood of the places alluded to, and a naturalist well known for his contributions to the natural history of our state, and for his attainments in that department of science, I have taken the liberty of appending to my preceding account the whole of his letter, omitting only the portion of it which refers to Woodboo Springs, as his description of those springs does not materially differ from that which I have already given:—

"At the next plantation below Woodboo another spring exists, but much smaller, pouring out its beautiful clear water at all times; it has attracted attention from the fact of its communicating, by subterraneous passages, with several openings near each other. It is upon the course of this spring that Mr. Robert Mazyck discovered the 'green sand' rich in Eocene fossils, and considered so valuable as a manure; indeed the most valuable which our marl-beds have yet furnished.

"The plantation above Woodboo, Wantoot, furnishes another extensive spring from the Eocene. The quantity of water thrown out is much less than at Woodboo, although the stream is considerable. There are several openings at various distances in the basin, through which the water issues; and these occasionally become closed, and new ones appear. These openings are all in the Eocene marl.

"Many years ago I observed a spring, quite small, just at the edge of the highland outside of the edge of the basin; and with the hope of getting an opening for the water, which was so conveniently situated for use, I removed the thin stratum of clay so as to expose the marl. I found the water issuing from a very small fissure in the marl; into which I bored with a common carpenter's auger, as deep as the instrument would permit. On withdrawing it, the water spouted up considerably above the surface. I then cut off a portion of my fishing-rod, a large cane, and punched out the joints, so as to make a continuous tube of about six feet. This was inserted in the auger-hole, and luted with clay; and the water immediately ran out at the top of the tube. This continued for several days, until the frequent removal and replacement of the tube made the hole too large to permit me to confine the water to the tube.

"In about a week, or perhaps longer, the opening increased to a foot in diameter, and a rod could be passed down eight or ten feet; and upon dropping a line into it, with about an ounce of lead, fish of considerable size were often caught. I have no doubt that these fish entered at the opening from the basin.

"At 'Pooshee,' near Black-Oak, the plantation of Dr. Henry Ravenel, there are several springs of this character, arising immediately from the Eocene.

"At Chelsea Plantation similar springs exist; and in several places in the woods there are small deep holes, containing clear water, called 'Fountains,' which communicate with openings into cavities in the Eocene marl. North of Pooshee, in the pine land, there are several of these fountains which communicate; the streams, like all those I have mentioned, running south, and emptying into a branch which is known as the 'Fountain Swamp.' These fountains are of the same character as the larger limestone sinks, well known through the marl region. They are caused by streams of water running through fissures or cavities in the marl, which gradually wear away the bed, increasing the cavities; the roofs of which are perpetually falling in, until they become too thin and weak to sustain the weight of the earth above them. When these streams are near the surface of the marl, small portions of the earth sink in, and *fountains* are formed. When the streams are deeper, large cavities are hollowed out below, before the mass above falls in, when the ordinary lime-sinks are formed: frequently these are quite dry, and many of them remain so after the heaviest rains; the water percolating through the earth, and finding its way to the stream, still existing below. At other times the streams are obstructed by the fallen mass, and deep ponds are formed, which have water at all times.

"The famous 'Eutaw spring in the field,' is an instance of a fountain formed by the breaking in of the earth; above one of

these streams, in the marl, near the surface, the water breaking over the fallen mass, fills a small basin, and then finds a vent into the old passage again, which seems to dip considerably as soon as it disappears, showing itself again at a short distance from the spring, in a bold stream known as Eutaw creek.

"Similar springs exist in the neighborhood, and probably in other portions of the Eocene region. The water contains carbonate of lime in solution, which affects its taste, although it is used every where for domestic purposes.

"At the lower lock at Blackoak, on the Santee Canal, the water from 'Pooshee Springs' passes under the lock by a brick aqueduct, the roof of which is never touched by the stream passing through it; and the whole arch is thickly studded with stalactites, formed by the evaporation of the canal water, which percolates through the brick work.

"These springs are outlets from streams of water in the Eocene bed, which are not connected: they are at different depths, and vary in size. Many have been diverted from their course, possibly, by the falling in of their roofs and superincumbent strata of earth, leaving portions of their track dry, and forming caves of greater or less extent, as is seen at 'Cave Hall,' in St. Matthew's parish.

"Some of these streams must be very large, as exhibited by the great spring at Woodboo. In 1815–16, when the supply of water to the upper portion of the Santee Canal failed entirely, so that the canal was dry for many months, the water from Woodboo spring furnished an abundant supply to keep the canal in navigable order from Coalhill lock to Cooper river; and the woodboats continued their business regularly. Between Coalhill and Blackoak, the canal was kept full by the springs from Pooshee, making the canal navigable up to the lower lock of Blackoak.

"This state of things continued so long, that the Canal Company expended considerable sums in experiments, in digging for water into the canal, which all failed. The Artesian well was not attempted; but in boring, if such a stream as that supplying the Woodboo springs should accidentally be entered, an abundant supply would at once be obtained. Unfortunately we have no data to determine the existence of such streams in any particular spot, or their direction; in boring for them, it must be mere chance which could make the experiment successful. Their existence should, however, be always kept in mind, in boring through the Eocene; and whenever a sudden escape of water occurs, it should be attended to, and not shut out by pipes, before its quantity or quality has been tested."

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Art. XVII.—*Description of two Reptiles from Oregon;* by Mr. Avery J. Skilton. (With a plate.)

Read before the Troy Lyceum of Natural History, Oct. 9, and Nov. 13, 1848.

Salamandra (Triton) granulosa, n. s. Tail about the length of the body, strongly compressed and carinated throughout. The animal wholly coarsely granular, except one inch of the tip of the tail.

Color, reddish brown above, orange beneath.

Length five and a half inches.

Described from a specimen preserved in spirits.

Cabinet of A. J. Skilton, and of the Troy Lyceum of Natural History.

The form of the tail leads to the idea of its being an inhabitant of the water, but I am informed it was found on the land. From *S. granulata* of Holbrook it differs as much in form as in color.

Brought from Oregon by Rev. Geo. Gary, superintendent of missions in Oregon.

Tropidolepis scincicauda, n. s. Slender, tail much longer than the body, cylindrical. Dermal plates of the body and tail, carinate above, smooth beneath, verticillate.

The carinate plates in nine rows.

Color, dusky green above, light ash color below. A row of small dark spots on each flank. Another row of smaller ones along the vertebral line. Some of the dark colored scales on the flanks tipped with a whitish color.

Length five to five and a half inches.

Described as above from a preserved specimen.

Cabinet of A. J. Skilton.

A well marked species. The size of the tail at its origin, from its resemblance to that of the skink, furnishes a strong specific character.

It is gratifying to be able to add another species to the two of this genus, previously known as belonging to North America. The specimens of this species as well as several of the T. undulata, so common in the middle Atlantic states, and also several skinks, resembling S. quinquelineatus, were caught by the Indians for the missionaries, with hair snares. They dreaded them, declaring they were poisonous.

Inhabits the country about the Dalles of the Columbia. Brought as above by Rev. Mr. Gary, superintendent of Methodist Missions.

The artist having to make out the figure by means of the specimens, it *may* be a little longer than the living animal.

Art. XVIII.—*Range of the Gutta Taban Collectors, and present amount of Imports into Singapore.**

In the first number of this Journal, an account of Guttá Tábán appeared, by T. Oxley, Esq., which we are happy to inform our able contributor has been republished in a very great number of periodicals both in India and Europe, and has been acknowledged on all hands to be the best and most complete description of the gutta that has yet been given.† At a later period we gave some details respecting its collection by the Orang Binua in Johore. At that time the principal supply was obtained from Johore, into the jungles of which, parties of Malays and Chinese had penetrated in all directions, while nearly the whole indigenous population were engaged in the search. In consequence of the equivocal position in which government appears to consider it politic to allow the Sultan to remain, the Tamungong has absolute power over the country, and it is to his energetic measures that Singapore has been indebted for a large part of the gutta hitherto imported. Following the usual Malay policy, the Tamungong declared the gutta a government monopoly, so as to secure to himself the greatest share of the profit on the product. The price allowed by him was a fair one, sufficient to induce the Malays to give the collection of gutta a preference to other employments, and to leave them a profit of 100 to 400 per cent. on what they procured from the Binua. The Tamungong himself sent out numerous parties of from ten to one hundred persons, and caused the tribes of hereditary serfs, such as the Orang Sletar, to be entirely employed in searching for gutta. For the same purpose the Sabimba tribe were transported into Johore from the forest of Battam. Subsequently the islands of the Johore Archipelago were laid under contribution, and "menaban"‡ became the cry amongst all their land, river and sea tribes. The Tamungong's collectors even went as far as Linga, and had procured a considerable quantity when the Sultan's eyes were opened to the value of his jungles. He confiscated a part of what had been collected, and following the Tamungong's example, declared gutta taban a royalty. At the period of our visit to the interior of Johore, the Tamungong had made arrangements with the Bindahara to secure the taban of Pahang.

The knowledge of the article has now slowly spread from Singapore in different directions, but we believe has not yet ex-

* From the Journal of the Indian Archipelago, for August, 1848, vol. ii, p. 529.

† Cited in this Jour., ii ser., v., 438, where the propriety of the name Gutta Taban is mentioned. The Malay word is *Gattá*.

‡ A word which the Gutta Taban has added to the Malay language. The greater number of Malay nouns admit of conversion into verbs by a prefix. Menaban, from taban, signifies to collect Gitta tábán.

tended to the geographical limits of the tree. The Singapore collectors have almost everywhere been the first to carry this knowledge to the natives of the different countries. To the north the gutta collectors have reached as far as Perak on the Peninsula side of the straits of Malacca (embracing Johore, Malacca, Salangor and Perak), and Siak on the Sumatra side as far as Pane and Bila. To the south the whole of the Johore Archipelago and the adjoining countries on the east coast of Sumatra as far as Plembang (including the forests on the Kampar, Indragiri, Tunkul, Rite, Jambi and Plembang rivers) now furnish taban. On the east coast of the Peninsula the knowledge of it has not yet advanced beyond Pahang. To the eastward it has reached some of the rivers of Borneo, such as Brune and Sarawak on the north, Pontianak on the west, and Koti and Passir on the east, coast. It thus appears probable that the range of the taban embraces the whole of Borneo. It is remarkable that although a botanist, Mr. Lobb, saw numerous taban trees in the jungles of Pinang, and Dr. Oxley in June last informed our mercantile readers there that it was found abundantly on the mainland opposite them, they do not appear to have been able up to this moment to get a supply on the spot, and they seem destined to wait till the knowledge of the tree slowly reaches the Malays of Kedah from Singapore. As it is now being disseminated in the adjacent state of Perak, it will probably soon advance to the latitude of Pinang.* Although the Dutch have many able botanists amongst them, they too, it would appear, have been obliged to await the slow indigenous process by which useful knowledge is diffused in the Indian Archipelago.

The following statements of imports into Singapore from 1st January to 12th July last, will give some idea of the present extent of the trade, and the relative proportion of taban furnished by the different countries. They are taken from the daily entries made at the office of the Registrar of imports and exports. About one half of the taban imported is not entered, but we have added the probable actual quantities.

I. *Malay Peninsula.*

Malacca,	225	piculs.
Muar,	11·50	"
Padang,	25	"
Batu Pahat,	·70	"
Indau,	155	"
Simpang,	50	"
Pahang,	126	"
	593·20	"

* Since writing the above, we have heard that 12 piculs of taban have been lately brought to Pinang from the southern part of Province Wellesley, adjoining Perak.

The greater part of the importations from Johore, &c. are not entered at the import and export office. The imports for the Peninsula have been probably about 2500.

II. *Johore Archipelago.*

Rhio,	559	piculs.
Gallang,	39½	"
Linga,	670½	"
	1269	"

III. *Sumatra.*

Siak,	209	piculs.
Kampar,	632	"
Indragiri,*	20	"
Tunkal,	46	"
Plembang,	156	"
Apong,	2·50	"
Kubu,	1	"
	1066·50	

The actual importations were probably from 1500 to 2000.

IV. *Borneo.*

Borneo Proper,	43	piculs.
Pontianak,	2	"
Koti,	10	"
	55	

There has been an import of 19 piculs from Batavia.

Excluding a shipment of 448½ piculs made at the beginning of the year, the exports have amounted to 6073-47, which must nearly represent the actual imports, as stocks are not kept in the place.

The imports from Johore have greatly diminished since last year. The tree in many districts has become so scarce that the taban obtained does not repay the time consumed in searching for it. The chief supplies must now be looked for from Sumatra, the northern countries of the Peninsula, and, above all, Borneo.

The total exports of taban from Singapore have been

in 1844,	1·68	piculs.
1845,	169	"
1846,	5364	"
1847,	9296	"
1848, to 31st July,	6768	"
	21,598·68	valued at $274,190.

* This is probably greatly under the mark. About 1,000 piculs are daily expected from Indragiri.

The whole of this has been sent to Great Britain, with the exception of 15 piculs to Mauritius, 470·68 to the continent of Europe and 922 to the United States.

About 270,000 taban trees have probably been felled during the 3½ years the trade has existed, and the value of each tree has thus, on an average, been about a dollar.

The price of taban in Singapore gradually rose from eight to twenty-four dollars per picul, but last month it began to fall and is now about thirteen dollars.

In our next, [Jour. Indian Archipelago,] we shall give some more exact details, and notice the mixtures of gutta percha, jelotong, gegrek, litchu and other inferior guttas, the products of different trees, which are sometimes used to adulterate the taban. A large lump was brought to us a few days ago consisting of gutta percha and gegrek, enveloped in a coating of taban about a third of an inch in thickness.

ART. XIX.—*Application of the Galvanic Circuit to an Astronomical Clock and Telegraph Register in determining local differences of longitude, and in astronomical observations generally, in a communication by* SEARS C. WALKER, Assistant U. S. C. S., addressed to Prof. A. D. BACHE, LL.D., Supt. U. S. Coast Survey:—forming a Report to the Treasury Department, by Prof. BACHE, and presented to Congress with a letter by the Secretary of the Treasury.*

I BEG to call your attention to the importance of the use of an electro-magnetic circuit and an astronomical clock in connexion with Morse's telegraph register for the operations of the coast survey, and the general purposes of practical astronomy. Your thoughts having been first turned to the subject of the use of Morse's electro-magnetic telegraph in the longitude operations of the coast survey, in December, 1844, special instructions were issued to me in the autumn of 1845. Under these and subsequent instructions, the operations of 1846, '47 and '48, entrusted to my care, have, until near the close of the latter year, been conducted without the use of the *automatic clock register*.

The importance of the latter instrument induced you to direct the necessary researches to be instituted, for the purpose of introducing it into use in the coast survey service. Several methods have been suggested by eminent mechanicians and electro-magnetists. That of Mr. Wheatstone is briefly alluded to in the proceedings of the Royal Astronomical Society, for Nov. 19th, 1841.

* Exec. Doc. No. 21, House of Representatives, 30th Congress, 2d Session.

The galvanic circuit in his clock, is made and broken by the use of a circular metallic disk put on to the arbor of the seconds' hand. Alternate intervals of a second, or one sixtieth of the circumference, are made of a non-conducting substance. The disk is insulated and connected with one pole of a galvanic battery. A delicate spring connected with the other pole presses gently on this disk. Thus the circuit is made and broken at alternate seconds. This mode enables the primitive clock to control the motion of any number of clocks in connection with it. Every time the circuit is broken or made, any receiving clock-wheel with sixty teeth may be made to advance one second, and this wheel may in the usual way control the minute and hour wheel.

Mr. Steinheil's galvanic clock is described in Schumacher's astronomical annual, for 1844. The particular machinery for making and breaking the galvanic circuit does not appear to be described; the general object is similar to Mr. Wheatstone's.

I find, as yet, no account of the actual application of these electro-magnetic circuits and astronomical clocks to the purpose of permanently registering the current of time on the running fillet of paper, as used in Morse's electro-magnetic telegraph. It is, however, this latter combination that we must employ in our telegraph operations for longitude. The experience of its advantages for that purpose, induces me, also, to recommend it for the general objects of practical astronomy, as far as relates to the record of minute subdivisions of time, such, for instance, as the determination of absolute or relative right ascensions of the heavenly bodies, or of the local time of their culmination.

The process to be used is dependent on two distinct contrivances. The first is to cause the most delicate astronomical clock to make and break the galvanic circuit at uniform intervals, (say of a second of time,) by an apparatus that cannot possibly injure its machinery or its rate of performance, when connected with the current of the most powerful battery. That of Mr. Wheatstone, and I presume of Mr. Steinheil, accomplishes this purpose effectually.

Professor Bond, without having seen any notice of Wheatstone's invention, had proposed to make the mechanical contact and separation of the pallet and teeth of the escapement wheel, the closing and breaking of the circuit. This method may be readily applied to insulated portions of these parts. It will certainly succeed in practice. It is, however, liable to the danger of deflagration of the metallic surface of contact, and perhaps to that of modifying the arc of vibration, by electric or electro-magnetic repulsion.

Dr. Locke of Cincinnati, to whom I mentioned your wishes on the 25th of October, not having seen a description of Mr.

Wheatstone's electro-magnetic clock, undertook to make a series of experiments on the subject. He succeeded, on the 6th of November, in inventing a method which like the former, is found to be perfectly successful in practice, and free from danger to the machinery and motion of the clock. Instead of a disk, Dr. Locke uses a wheel with sixty teeth, each of which when horizontal strikes against the handle of a platinum tilt hammer, weighing about two grains, and knocks up the hammer, which instantly falls to a state of rest on a bed of platinum. The fulcrum of the tilt hammer and the platinum bed rest severally on a small block of wood. Each is connected with a pole of the galvanic circuit, and the circuit is alternately broken and made by the rising and falling of the hammer. The latter operation takes about one-tenth of a second of time.

I think it is manifest that either method will succeed in practice, which alone can test their relative excellence. To Mr. Wheatstone, however, belongs the merit of priority in effecting the primary object of causing the astronomical clock to make and break the circuit of a galvanic battery, without injury to the machinery or movement of the clock.

Waiving the question of the relative excellence of the two inventions, and leaving it as a subject for special experiments, I come now to the second requisite for the fulfillment of your wishes, viz: the connexion of the astronomical clock with Morse's electro-magnetic telegraph. In this department, so far as I am informed, the first experiment has been made in this country.

An experiment of the combination of an electro-magnetic clock and Morse's telegraph register, was made by Professor Mitchell and myself at the Cincinnati observatory on the 26th of October last, on a plan, however, which I did not consider to be suitable for nice astronomical observations.

On the 17th of November last, Dr. Locke's delicate astronomical clock, of his own construction, was supplied with the requisite apparatus made from his drawings by his son. At the expense of the coast survey, I directed wires to be put up for the purpose of connecting his clock with the Cincinnati and Pittsburg line, about four hundred miles in length. The experiment was eminently successful, and the registering of the seconds of time on the running fillet of paper was continued for two hours at all the offices along the line, much to the astonishment of the operators. I send you a specimen of the graduated fillet of paper. It consists as you will notice, of an indented line of about nine-tenths of an inch in length, followed by a complementary blank space of about one-tenth. The two make a second of time, commencing with the beginning of the line.

This graduated fillet of paper I will call for the present the *automatic clock register*, whether it is furnished by Wheatstone's

or Locke's apparatus for attachment to the arbor of the seconds hand of the primitive clock.

In order to carry out fully your wishes and instructions, it would be necessary that this automatic clock register should distinguish the hours, minutes and seconds. Dr. Locke proposes for this purpose to make the beginning of the ordinary minutes omit *one*, of *fives* of minutes *two*, of *tens* of minutes *three*, and of *an hour* omit *four* consecutive blank spaces. Thus *ordinary* beginnings of minutes have continuous lines of *two* seconds, *fives three*, *tens four*, and *hours five*.

The mode of using the register for marking the date of any event that cannot be determined *automatically*, but whose occurrence must be known from human sensations, is to tap on a *break circuit key* simultaneously with the event. The beginning of the short blank space thus registered in the midst of the indented line of the *automatic clock register*, fixes, by a permanent printed record, the date of the event, or rather the date of the human estimate of the event, as indicated by the tap of the key.

For this mode of distinguishing the hours, minutes and seconds on the fillet of paper, and for the idea of using the break circuit key, I was indebted to Dr. Locke. This kind of key is required by the necessity of having a closed circuit for the *register* as much of the time as possible, so that an event occurring any where along the line may be instantly recorded on the register.

Having thus given credit to Mr. Wheatstone and to Dr. Locke for the parts severally performed by them in the perfection of this process, I beg to suggest the following slight modification of Dr. Locke's mode of marking seconds, whether we use for our automaton Wheatstone's circular disk or Locke's toothed wheel and platinum tilt hammer. I would mark the beginnings of ordinary fives and tens of minutes and hours, as Dr. Locke does. I would make the blank spaces of the other ordinary seconds the smallest possible consistent with the certainty of breaking circuit. The blank spaces of the *fives* of seconds should be visibly larger, those of *tens* still larger, finally those of *thirties*, largest of all.

By this arrangement the eye would readily distinguish the exact value of the numbers of whole seconds. An inch of paper is, I think, enough for a second of time. The probable error of the reading of the fractions of a second with a proportional scale or compass, will not be greater than one hundredth of a second. I would have the register adjusted by a centrifugal clock like those of the Munich equatorials, so as to deliver, as near as may be, one hundred inches of paper in one hundred seconds of time of the *automaton clock register*.

Instead of a proportional compass we may use a graduated scale of some translucent substance laid on the printed register. For the sake of uniformity of hygrometric expansion, a graduated scale made of a portion of the registering fillet will perhaps be preferable. A small correction may in this case be applied if necessary, for the rate of the automatic clock on an assumed scale of paper of a second to an inch. A relative rate of two seconds per minute (an improbable occurrence) will on the average cause only an error of one hundredth of a second in reading off by the scale.

All that I have now proposed may be accomplished by the first disk or toothed wheel and tilt hammer.

Dr. Locke's mode of distinguishing the subdivisions of minutes appears to be satisfactory. I see no reason why it may not be effected by a toothed wheel on the arbor of the minute-hand, and another on that of the hour-hand. I mention this for the sake of simplicity, leaving to the mechanician his choice of the mode of effecting the purpose.

In printing on this *automatic clock register*, the dates of such events as a series of bisections of a star by the successive wires of a transit instrument placed at equatorial intervals of two seconds or more, short blank spaces may be made by dwelling for a very small time with the finger on the *break circuit key*.

Isolated events, like the phases of an eclipse or of an occultation, may be distinguished by dwelling with the finger on the key for a space of time longer than the maximum of blank space used in distinguishing the thirty seconds.

In this way we cannot fail of imprinting the date of an event. If the signal break circuit tap occurs in the midst of one of the small blanks, this precaution will secure the record, with an average liability to error for such rare instances, of only one-fourth of the actual blank space of the *automatic clock register*.

Washington City, Dec. 15, 1848.

Having, in the first part of this special report, given a brief history of the steps that led to the invention of the automatic telegraph clock, and of its application to Morse's electro-magnetic telegraph, I beg to offer you such suggestions as have occurred to me in relation to the practical application of it to the longitude operations of the coast survey, and to the general purposes of practical astronomy, on which the survey is dependent for the accuracy of its work.

The great importance of an automatic telegraph clock has often been the subject of conversation between us, but your chief efforts were, necessarily, directed at first to the means of procuring it. A hasty glance at the advantages that would result from the certain possession of such an instrument was made by Dr.

Locke and myself, on the evening of the 17th of November, while watching its performance for a term of two hours or more. Having reflected much since, and consulted with my friends both in and out of the coast survey, I am more and more convinced that it is difficult to form an over estimate of its importance in every department of practical astronomy that involves the nice determination of absolute dates, or of their relative intervals in time. Throughout the whole range of practical astronomy, epochs of time and their relative intervals have been hitherto measured by astronomers by listening to the beats of a clock or chronometer, and estimating the fraction of a second between them when any event has occurred, such as a phase of an eclipse, an occultation of a star, or a bisection of a star, comet, or planet's centre or limb, by the wires of a transit instrument. This use of the ear has been a matter of necessity, not of choice. It is, in every respect, in the subdivisions of time and space, a very imperfect organ. While the eye readily estimates the proportional parts of a line with the precision of a tenth, the ear seldom distinguishes smaller portions of an interval of time than a fifth.

In the case of observing transits of a star with a seconds clock, when greater precision than the estimate of a fifth of a second is required, it is only obtained by long practice and experience, and by the use of an *ocular* estimate of portions of space where the star *was* at the time of bisection, and where it was *seen* to be at the time when the two beats immediately preceding and following this bisection were *heard*.

In order to increase the precision of the comparison of two sounds together, in point of time, it is necessary gradually to diminish their interval asunder until the *minimum audible* of about a hundredth of a second is attained. This advantage attends the comparison of chronometers by coincidence of beats, when one has a more rapid movement than the other; but it cannot be brought to bear upon the association of the time of a visible bisection of a star with the date of the hearing of the beats of a clock. The average uncertainty of such an association, as appears from my last report of the result of four thousand experiments on this subject, among the officers of the coast survey, is seventeen hundredths of a second. Of this sum, the greater portion is probably due to the imperfection of the ear as an organ, in associating its sensations with those of sight. I do not speak now from actual experiment, as I hope to do another year. It is well known, however, that the nerves and sensations of sight and touch are far more intimately connected together than those of the eye and ear.

I have repeatedly noticed the advantage of the substitution of the sense of touch for that of hearing in the use of *chronographs* for making a visible register of the dates of bisection of transit

wires by a star. I have known persons afflicted with deafness, and, from that circumstance, compelled to resort to the use of chronographs, to make more precise observations than those of persons in other respects similarly situated; but who, having good sight and hearing, estimated fractions of a second by means of the use of the eye and ear. I think we may assume, subject, however, to correction by actual experiment, that the precision of the combinations of sight and touch is to that of sight and hearing nearly as seventeen to ten.

This estimate supposes that no error is committed in the mechanical operation of imprinting and reading off.

Now, this certainty is furnished for the first time in the history of the science by the use of the automatic telegraph clock. The objection to the use of chronographs in an observatory has arisen from the uncertainty of their rates, and from the necessity of immediately transcribing and obliterating the record made on them for the purpose of identifying it, and preparing the dial for a fresh record. Both of these objections are removed by the use of the *automatic clock register*.

The rate of this register has all the precision known to astronomers. The length of a continuous fillet is limited only by the size of the paper reels that may be considered convenient for use. An eight-day clock might be made to deliver a continuous graduated register from one winding to another.

A single label on any part of it, to identify one of the seconds, fixes them all.

I have before remarked that the error in the mechanical part of imprinting a date on the *automatic clock register*, and in reading off, need not exceed a hundredth part of a second. It may, in fact, be reduced to a ten-thousandth part of a second by substituting for the paper fillet a metallic cylinder revolving like a barrel organ, and graduating the seconds on a spiral line. Perhaps Mr. Bains's method of registering on a paper, in a spiral line, may supersede Mr. Morse's running fillet.

The great advantage of the method of imprinting the dates of bisections of a star, by the wires of a transit instrument, does not depend merely on the increase of the precision of a single result.

The facility of acquiring the practical skill necessary for tapping on a key, at the date of a visible bisection, is very great. A few hours in this respect take the place of months, if not of years, spent in learning to associate together the sensations of sight and hearing, so as to make a good transit observation.

The third and paramount advantage of the method of imprinting the dates of bisections of wires by a star, is in the *sevenfold* accumulation of results in a single culmination, or in a given period of time.

Fifteen seconds is the ordinary equatorial interval for the wires of a transit instrument, and we have the authority of the greatest of practical astronomers, the lamented Bessel, that five wires, with this interval, are better than seven wires compressed into the same space.

By using the method of imprinting the dates of the bisections of these wires, on the *automatic clock register*, where the use of the ear, and the counting of beats, and the manual labor of writing down these dates, are all dispensed with, the equatorial intervals may be reduced from fifteen to two seconds, or even to one and a half.

In this manner the number of bisections in a single culmination of a star may be multiplied *sevenfold*, as I have already mentioned.

The advantage of the method of imprinting dates of bisections of wires by a star on the *automatic clock register*, from those three separate sources of gain, may in round numbers, be estimated at *tenfold.*

The remarks that follow are based on such an estimate, and are consequently subject to a proportional modification, when the true numerical ratio shall have been determined by experiment. According to this estimate then, we are authorized to conclude, THAT THE VALUE OF A NIGHT'S WORK WITH A TRANSIT INSTRUMENT, BY THE PRINTING METHOD, IS ABOUT TEN TIMES AS GREAT AS BY THE METHOD NOW IN USE AMONG ASTRONOMERS.

For moon culminations, which depend upon the comparisons of transits of the same heavenly bodies, here and in Europe, *fifty* wires may take the place of *seven*, and one *month's* work may take the place of a year's work in the manner hitherto performed.

For catalogues of stars, such as were formerly made in Paris and Konigsburg, and are now made at Munich, Bonn, and Washington, where a transit over one wire only, is usually observed in a night, *seven* transits may now take the place of *one*, and from the superior facility which the printing method gives of adjusting the transit instrument, the subject of the right ascension of the stars of such catalogues may now be exhausted for the epoch of the observation.

In the case of the *ten year* catalogues of the right ascension of stars, from the royal observatory at Greenwich, the same labor spent by the astronomer at the transit instrument, by the use of the printing method, may furnish one of equal precision *every year.*

I am bound to make an exception in favor of the catalogues of stars furnished by Mr. Rumker from the Hamburg Observatory. This indefatigable astronomer, by some process apparently unknown to his professional brethren, has already doubled the ordinary number of bisections of a star at a single culmination.

In his catalogues of right ascensions of stars the use of the printing method would only introduce a *fivefold* instead of a *tenfold* gain.

I venture to suggest that our National Expedition to Chili, under Lieutenant Gilliss, will by the use of the printing method, furnish nearly *ten* times the precision in the value of the parallax of Mars, from his relative transits with the same star, both east and west of the meridian, that would result from the ordinary method of observation.

There is, however, no one branch of practical astronomy, or coast survey operations, where the benefit of the *automatic clock register* will be so great as in the determinations of relative longitude of the stations.

One night's work with the printing method will be worth as much as any single campaign has been heretofore between any two stations.

The importance of this branch of the duties of the coast survey induces me to dwell more at length on the subject. Your operations propose, for the first time in the history of geodesy, to measure astronomically a long arc of a parallel with a precision commensurate with the former and present astronomical measures of arcs of the meridian.

I would, for this purpose, respectfully recommend the mounting of one of Mr. Wheatstone's, or of Dr. Locke's, clocks at some central astronomical station, having easy telegraph communication with the northern and southern points of the coast survey. This central station, and any other one or more stations intended to be compared together, may be supplied with transit instruments, constructed with special reference to the advantages of the printing method. I would respectfully recommend the use of a transit instrument with a frame of a cast iron box, and with three or more doubled faced levels on each side suited to both zenith and nadir pointings. When not too cumbersome, as in the case of the coast survey instruments, I would wish for an azimuth adjustment, with graduated micrometer head, like the Simms transit instruments now in use in the coast survey. I would wish to retain the principle of rapid reversals, and would extend it to zenith stars. The inner portion of the pivots may rest on counterpoises with friction rollers. I would wish the reversing apparatus to have the following advantages, leaving to the mechanician the decision as to the mode of securing them. The time occupied in the reversal and in repointing the instrument, by making it revolve on its axis through the double of its zenith distance before reversal, should not exceed twenty seconds. The pointing may be done by means of an adjustable clamp, suited to the declination of the star. The pivots need not be elevated more than half an inch in order to move free of the

sockets. Two turns of a screw might elevate; one turn more reverse it, and two more turns place it at rest on the socket and friction rollers.

The net work of the transit instrument may consist of groups of five wires, each separated by an interval of once and a half the ordinary space.

For the sake of rapid observation of circumpolar stars, the inner group may have half the ordinary interval. In the case of equatorial stars, only three of these wires need be used. The equatorial intervals may be one for the inner, and two seconds for the other groups. The intervals between the groups may be three seconds. My micrometric measures, with the great Fraunhofer equatorials, show that fifteen-hundredths is an ordinary, and two-tenths of a second of time an extreme value of the subtense of a spider line for a four foot tube. The smallest clear intervals between the wires would be *four*, the ordinary *nine*, and the greatest *fourteen*, diameters of the opake wires.

The number of these tallies may be seven, nine, or eleven, according to the focal length of the telescope, and the mechanical facility of graduating the diaphragm and of setting the spider lines. Since the register is permanent, and may remain for reference, it is only necessary to enter in the written journal the mean for each tally from the mean of the five readings. To prevent the accumulation of these registers from filling too much space, the same fillet of paper may have several parallel lines of the *automatic clock registers* imprinted on it, by means of a micrometer motion of the graver.

Where the observatory is fixed, and the line short, and the Grove's cups are charged anew with acid every day, the registering fillet may contain one or two months' continuous record on one reel. All the transits observed in the occupancy of a single temporary station may be preserved on one reel. In order to identify dates, and particularize records, the observer keeps a memorandum book in which he records the level readings, and refers to each celestial object by a letter or number, with accents or side numbers denoting the order of the lines on the fillet.

A duplicate mark is made on the fillet itself. A receiving reel of dimensions similar to the delivering one, affords a compact disposition of the printed register. A tell-tale check connected with it will enable the transcribing clerk to turn at once to any date on the paper, without examining the intermediate spaces.

In using these instruments for longitude operations, zenith stars are selected at the eastern station. The declination clamp is adjusted ready for reversals.

The levels are all read. Twenty dates of bisections in the first position of the instrument are imprinted, the reversal and re-pointing is effected, twenty more bisections by the same wires in a

reversed position of the instrument are imprinted, the levels are again read, and the registering fillet labeled. The same operation is repeated on the same star at the western station. The electromagnetic clock may be rated at the central station. The *automatic register* may be kept there, and the printed record may be there preserved. Check registers may be kept at the other stations. The imprinted culminations of two fundamental stars at the same station, whether eastern, or western, or central, will serve to fix the rate of the primitive clock. The reversals remove the error of collimation, and furnish, by taking the means of the printed dates for each wire, twenty normal bisections with reference to the optical axis of the telescope. On applying the corrections for the levels, we have twelve normal level readings with reference to the zenith and consequent meridional point near the position of actual observation. The facility of observing transits of circumpolar stars, gives extraordinary precision to the azimuth correction, which moreover nearly vanishes with circumzenith stars.

A consideration of these numerous advantages of the printing method for longitude of stations, leads me to believe that one single culmination of a circumzenith star at each of the two stations thus observed, may give their relative longitudes to a few hundredths of a second, which is all that can be said of our present knowledge of those of the Greenwich and Paris observatories, the two oldest in the world. The check readings of the levels with nadir pointings adds to the certainty of the work. If the concluded difference of longitudes of the zenith and nadir portions of the meridians conform, our confidence in the result is much strengthened.

If the discrepancy is sensible, the mean of the results may serve to eliminate any want of symmetry in the pivots or sockets, or any irregular action of gravity or sudden change of temperature on the parts of the instrument.

In the above process all sources of error in the result are eliminated except the difference of the *break circuit armature* times, and personal equations of the astronomers in tapping on the key. The rule adopted in good telegraphic offices, and which must be inflexibly adhered to in all astronomical operations, of adjusting the *outer* and *inner* limits of *armature distance* to a *minimum* value, secures us against error from the first source. When the total quantities are so small as to be insensible to the ear, their difference, which is a term of the second order, must necessarily be evanescent.

The personal equations of tapping on the key for the instant of a bisection are much smaller than those which arise from the combination of sight and hearing.

They are also more uniform and less dependent upon the nervous temperament of the individuals. They may be determined in a few minutes' time by the astronomers, on meeting at the same station, by striking alternate wires, each party being alternately a leader. A few pairs of culminations printed in this way fix the value of the equation if any exist.

These views, which I have felt it my duty to lay before you at length, are the result of a separate trial of each of the processes involved in the art of imprinting dates. The experience of the last summer furnishes some six hundred cases of imprinting dates on an ungraduated fillet of paper. Dr. Locke's electro-magnetic clock, on the 17th of November, furnished an ample trial of the method of *graduating* the paper.

The combination of the two operations so as to imprint the dates of culminations on the *automatic clock register*, would have been tried that night, but for the failure of the line from Pittsburg to Philadelphia. The full trial, however, of the combination in all its perfection, requires the construction of the proper instruments; with them, under your instructions, I hope, at an early date, to submit these opinions to the test of practical experiment.

Permit me to say a word on the experience of the Coast Survey in regard to the length of telegraph lines. This year we made abundant experiments on the line from Philadelphia to Louisville, a distance in the *air* of *nine* hundred miles, and in circuit of *eighteen* hundred miles. The performance of this long line was better than that of any of the shorter lines has hitherto been.

Not more than two or three good astronomical nights, at Cincinnati and Philadelphia, were lost by failure of any part of the line, in the periods of nearly two months of our stay at Cincinnati. I learn from an authentic source that the same success attends the work from Philadelphia to St. Louis, A DISTANCE IN CIRCUIT OF ONE-TWELFTH OF THE EARTH'S CIRCUMFERENCE.

The number of Grove's pint cups used is about one for every twenty miles. It is natural to conclude from this experiment, that if a telegraph line round the earth were practicable, *twelve hundred* Grove's pint cups, in equi-distant groups of fifties, would suffice for the galvanic power for the whole line.

The daily expense of acids for maintaining this motive power, would be about five mills per day for each cup, or six dollars per day for the whole line.

Washington, December 15, 1848.

Art. XX.—*Parallelism of the Palæozoic Formations of North America, with those of Europe;* by **Ed. de Verneuil**, translated, with annotations by **James Hall**.

(Continued from p. 51.)

M. de Verneuil, in the conclusion of his paper on the parallelism of the European and American formations, offers some general remarks upon the species of fossils common to the two countries, showing by a table of the successive groups the geological range of the species. The first part of this we have translated entire, while in the remainder we have noticed only those species concerning which there exists some difference of opinion.

We give in the following Table, the list of species common to Europe and North America. This list is made from our own observations, that is to say, we have seen in collections or in the rocks the species which are here enumerated. We have placed opposite to each species columns corresponding to the thirty-one groups of which the palæozoic formation in the United States is composed, and we have indicated by asterisks those of the groups where they are found. We can thus, by a simple inspection of the table, easily understand the different duration of the species, and distinguish those which traverse many systems from those which are limited to a single one. We can, moreover, which is also essential, follow the succession of these last in the different stages which compose that which is called a system. It will be perceived that the species have very seldom lived throughout the entire duration of the system of which they are said to be characteristic; that they have set out from different levels, and that between the first and last beds, differences thence result, which appear to prepare for the establishment of the succeeding system.

The table contains one hundred and seventeen species, or about one-fifth of all those which we have seen during our journey. The four-fifths of the fossil species of the palæozoic series of North America appear, then, to be peculiar to this continent,* and thus prove to us that from the earliest times of creation, animals observed, in their geographical distribution, laws more or less analogous to those which govern them at the present day.

* This is very nearly the proportion which we have already indicated in our work upon Russia. (Geologie de la Russie d'Europe et de l'Oural, vol. ii, p. 31.)

[In the first volume of the Palæontology of New York, embracing descriptions of three hundred and eighty species of lower Silurian age, not more than one-twentieth part can be regarded as identical with species heretofore described in Europe. This number includes, however, some species known to occur in Europe, but which have never been described, though it is not probable that the proportion of species of this period common to the two continents will ever be found as great as the proportion given by M. de Verneuil. In the upper Silurian and Devonian periods, the proportion of species common to the two continents is probably greater than in the lower stages.—J. H.]

TABLE

Of the species common to Europe and North America and of the subdivision of the palæozoic formation in which they occur.

	Lower Silurian.						Upper Silurian.									Devonian.								Lower Carbn'f.		
	1. Potsdam sandstone.	2. Calciferous sandrock.	3. Black River limestone.	4. Trenton limestone.	5. Utica slate.	6. Hudson River group.	7. Gray sandstone.	8. Oneida grit.	9. Medina sandstone.	10. Clinton group.	11. Niagara group.	12. Onondaga salt group.	13. Water-lime group.	14. Pentamerus limest.	15. Delthyris shale.	16. Upper Pentam. limest.	17. Oriskany sandstone.	18. Cauda-galli grit.	19. Scoharie sandstone.	20. Onondaga limestone.	21. Corniferous limestone.	22. Marcellus shale.	23. Hamilton group.	24. Tully limestone.	25. Genesee slate.	26. Portage group.	27. Chemung group.	28. Old red sandstone.	29. Micaceous sandst.	30. Carbonifer's limest.	31. Carbonif. formation.
Holoptychus nobilissimus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.
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Calymene Blumenbachii.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*?	.	.	.	.	.	.	.	.	.	.	.
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Illenus crassicauda.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lichas laciniata.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cenurus pleurex'mus.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trinucleus caractaci.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phacops Hausmanni.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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" macrophthalmus.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	*?	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.
Cryphæus calliteles.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.
Bomastus barriensis.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Homalonotus delphin's.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cheirurus insignis.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sphærexochus mirus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agnostus latus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phillipsia seminifera.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Orthoceratites communis.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Lituites convolvans.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Conulites rotatorius.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Nautilus tuberculatus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bellerophon hiulcus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Pleurotomaria lenticularis.	.	.	.	*	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Subulites elongata.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euomphalus carbonarius.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Macrocheilus curvilineus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chemnitzia nexilis.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.
Murchisonia bilineata.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Avicula damnoniensis.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.
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Modiola squammifera.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Allorisma sulcata.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Terebratula cuboides.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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TABLE

Of the species common to Europe and North America and of the subdivision of the palæozoic formation in which they occur.

	Lower Silurian.						Upper Silurian.									Devonian.												Lower Carb'n'f		
	1. Potsdam sandstone.	2. Calciferous sandrock.	3. Black River limestone.	4. Trenton limestone.	5. Utica slate.	6. Hudson River group.	7. Gray sandstone.	8. Oneida grit.	9. Medina sandstone.	10. Clinton group.	11. Niagara group.	12. Onondaga salt group.	13. Water-lime group.	14. Pentamerus limest.	15. Delthyris shale.	16. Upper Pentam. limest.	17. Oriskany sandstone.	18. Caudo-galli grit.	19. Scoharie sandstone.	20. Onondaga limestone.	21. Corniferous limestone.	22. Marcellus shale.	23. Hamilton group.	24. Tully limestone.	25. Genesee slate.	26. Portage group.	27. Chemung group.	28. Old red sandstone.	29. Micaceous sandst.	30. Carboniferous limest	31. Carbonif. formation.
Terebratula Wilsoni.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Graptolites sagittarius.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Total,	0	0	3	18	1	6	0	0	0	12	27	0	2	3	7	0	2	0	4	6	16	1	18	2	0	2	8	2	14	16	16

Remarks upon the Palæozoic Fossils common to America and Europe, and upon the relations which they offer in their distribution.

Holoptychus nobilissimus, (Agass.)—This fish, characteristic of the old red sandstone of Scotland, England, and Russia, is found at Blossburgh, in Pennsylvania, in the thick stage of the sandstone which forms the superior part of the Devonian system.

Dendrodus, (Owen.)—We think we are able to refer to this species the tooth figured by Mr. Hall in his final Report on the Geology of New York, (page 281, fig. 4,) and found at Blossburgh with the preceding species. The genus *Dendrodus* is characteristic of the old red sandstone of Scotland, and the Devonian beds of Russia.

Asterolepis, (Eichw.)—We refer to this genus two fragments of American fishes; one which we have seen in the collection of Mr. Gebhard,* and which he told us had been found in the calcareous sandstone of Schoharie, and the other which we purchased, and which appears to have come from the Hamilton slates. This last presents no points of difference from the specimen which I found in the Eifel.

Calymene Blumenbachii, Brong.; *C. senaria*, Conrad.—Mr. Conrad has given the name of *C. senaria* to a variety of *C. Blumenbachii* which is found in the most ancient palæozoic beds, (the Trenton limestone and the blue limestone of Ohio,) which is distinguishable from the species of M. Brongniart only by the contraction of the front part of the middle lobe of the head; a character which allies it, in some degree, with the *C. Tristani*. The true *C. Blumenbachii* unquestionably exists in America in the upper Silurian system, (*Clinton* and *Niagara groups*.) Its var. *major* figured by Murchison, (Silurian system, plate 7, fig. 6,) and named by Mr. Green *C. platys*, would be found according to this author in the calcareous sandstone of Schoharie. If this is so, this variety which belongs in England to the Ludlow stage, must have lived in America in beds which we consider a little more recent.†

* The collection of Mr. John Gebhard, Jr, is one of the richest for the series of rocks and fossils which constitute the hills of the Helderberg around Schoharie, and its owner does himself pleasure in making it accessible for the inspection of strangers.

† [It appears to us that the *C. senaria* is distinct from *C. Blumenbachii* of Dudley. The Niagara species, which is similar in character, possesses features somewhat more like the Dudley specimens. The *Calymene platys* of Green, which occurs in the Schoharie grit, is always much larger than either of the preceding, and possesses other characters which seem sufficient to distinguish it as a species. Regarding for a moment this species as identical with the older forms, we have the *C. Blumenbachii* appearing in the lower Silurian strata very abundantly, and reappearing in the Niagara group, while during the subsequent deposits of water-lime,

C. Fischeri, Eichw.—This species, characteristic of the lower Silurian limestones of Russia and Sweden, is found at Knoxville, in Tennessee, at the base of the palæozoic series. Prof. Troost has a beautiful specimen of it. It is recognized by the twenty-three articulations of which it is composed. We think we might unite with it the *Amphion pseudo-articulatus* of Portlock, of the lower Silurian stage of Ireland.

B. punctata, Brünn., sp.; (*C. variolaris*, Brongn., not Murch.)—This species has been found by Mr. Hall at Middleville, in the Trenton limestone, and by Mr. Norwood at Madison, Ia., in the lower layers of the cliff limestone, which correspond to the Clinton group. We have seen it also at Springfield, Ohio, with the *Pentamerus oblongus*, in the magnesian limestones, which are undoubtedly parallel to the Clinton group. In England the *C. punctata* is found both in the sandstones of Caradoc, and in the schistose slates of Wenlock. In these same slates it is found in the island of Gothland. In the islands of Dago and of Œsel, as well as in those of Christiania, the *C. punctata* appears to be found near the line of junction of the superior and inferior stages of the Silurian system.*

Illænus crassicauda, Wahl. sp. (*Bumastis trentonensis?* Emmons.)—We have seen only detached parts of this species, and principally the post abdomen or pygidium. It belongs to the most ancient beds. We recognize it upon the Black River, and in the vicinity of Trenton, New York, in Pennsylvania, and at Knoxville, Tennessee, where it is associated with the *C. Fischeri*. This species occupies the same position in Europe, and belongs exclusively to the inferior stage of the Silurian system in England, in France, in Sweden, and in Russia.†

Lichas laciniata, Wahl., or perhaps *Lichas scabra*, Beyrich.—It is very difficult to say to which of these two species we should refer the beautiful specimen found by Mr. Carly in the blue limestones of Cincinnati.

Pentamerus limestone and Delthyris shaly limestone, in which we know some eight or ten species of trilobites, this one never appears; and yet after the deposition of the Oriskany sandstone and Cauda-galli grit, we find it flourishing in considerable numbers and of increased size. Its non-appearance during the intermediate period seems an argument against the identity of the species in the two positions, aside from other characters by which we regard it as positively distinct. —J. H.]

* [I do not regard it as well ascertained that the species from the Trenton limestone and the Clinton group of New York are identical. The species from the Trenton limestone is given under the genus Ceraurus, in the first volume of the Palæontology of New York. It is not a true Calymene, having the facial structure like Phacops, with eyes differing from either genus. I have shown some slight differences between our species and that of the Wenlock formation of England; and there are other and more important differences between the one already described and that in the Clinton group.—J. H.]

† [The Bumastis trentonensis of *Emmons*, Illænus trentonensis, Pal. N. Y., vol. i, p. 230, pl. 60, fig. 5, appears to be quite distinct from *I. crassicauda*, and is an extremely rare species, while the latter is of frequent occurrence.—J. H.]

The *Lichas scabra* of Bohemia belongs, according to Mr. Barrande, to the lowest beds of the upper stage of the Silurian system, while the *Lichas laciniata* of Sweden, is found, like that of America, in the lower stage. We have seen in the collections of Mr. J. Hall, at Albany, a specimen very much like that of Cincinnati, coming from the Trenton limestone.

Ceraurus pleurexanthemus, Green.—In comparing the fragments of the head which I possess, of this species with the *Cheirurus exsul*, Beyrich, I have not been able to discover any difference. This author, like ourselves, knew only of the head of the *Cheirurus exsul*, which has been found in the bowlders of limestone coming from Scandinavia, and containing the most characteristic trilobites of the lower stage of the Silurian system, such as the *Asaphus expansus* and *Illænus crassicauda*. The *Amphion gelasinosus*, Portlock, of which this author has seen only the head, and which appears also to be the same species, belongs to the lower Silurian beds of Ireland. The *Ceraurus pleurexanthemus* characterizes also the same stage in America. We have found it at Middleville, N. Y., in the Trenton limestone, and at Galena, Illinois, in the blue limestone. Mr. D. Dale Owen says he has found it at Cincinnati in beds of the same age.*

Trinucleus caractaci, Murch.—This species is abundant in America, chiefly in the Hudson River group of the State of New York. It occurs also in the blue limestone of Cincinnati, and of Newport, in Kentucky. According to Prof. Emmons, the *T. tessellatus*, Green, very abundant in the lower beds, that is to say, in the Trenton limestone at Sackets Harbor, at Glens Falls, N. Y., and at Montreal, is distinguished from the *T. caractaci* by the shorter spiniform prolongations, by the narrower perforated limb, and by the number of perfect circles of perforations which would be three instead of four.† The *T. caractaci* belongs in Europe to the middle and upper region of the lower Silurian stage, and is found principally in the sandstone of Caradoc. All the species of Trinucleus are in general proper to the lower stage of the Silurian system. We know no exception to this rule in America, and we know only one in Europe.‡

Phacops Hausmanni, Brongn., sp.—This species, in Bohemia, proper to the higher and middle divisions, appears in America in exactly the same position, that is to say, in the Pentamerus gale-

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* [This peculiar and well marked species is evidently identical with the *Cheirurus exsul* and *Amphion gelasinosus* cited above, and also with *Calymene? speciosus*, Dalman. It is also closely allied, or identical with several other European species which have been described from fragments. (See Pal. N. Y., vol. i, p. 242.)—J. H.]

† Mr. Hall thinks, nevertheless, that the *T. tessellatus* and *T. caractaci* should be united. [See Pal. N. Y., vol. i, p. 249.]

‡ It is said that Trinucleus has lately been found in the slates of Wenlock.

atus limestone, and in the Delthyris shales of the State of New York. It has been described by Mr. Green under the name of *Asaphus micrurus*. According to Mr. Troost, (sixth Report,) it exists also in Tennessee. [The *Asaphus pleuroptyx*, Green, is also identical with *P. Hausmanni*.—J. H.]

P. Dalmani, Portlock.—Discovered by Mr. Portlock in the lower Silurian stage of Ireland, this species occurs in the same horizon in the Trenton limestone of New York.* Closely allied to the *P. Downingiæ*, it is distinguished by its glabella being more triangular and greatly contracted near the base.

P. limulurus, Green.—The only difference between this species and the *P. mucronatus*, Brongn., or *P. longicaudatus*, Murch., consists in the form of the tail, which is shorter with a wider base. If this difference, observed in a greater number of specimens than we have been able to see, obliges us to maintain the specific separation of *P. limulurus*, perhaps it might be considered as intermediate between the *P. mucronatus* and *P. caudatus*. There is besides, with these two species a great similarity of position. It is found in the schistose slates of Niagara, as the two preceding species are in the slates of Wenlock. The *P. mucronatus*, nevertheless, in Brittany, descends as far as the lower Silurian schists, while the *P. caudatus* remains limited to the Wenlock group, the same as the *P. limulurus* to the Niagara.

We have found also in the west of the United States the pygidium separated, too incomplete to be referred with certainty either to the *P. limulurus* or *P. caudatus*. These specimens are not rare in the cliff limestone of Ohio and Indiana, which corresponds to the Niagara group. One of these incomplete pygidia belonging perhaps to the *P. limulurus* was given to us at Dayton, Ohio, by Mr. Vancleve, as coming from a yellow limestone which appears to be intermediate between the two great Silurian stages.

P. macropthalmus, Brongn.; (*Calymene bufo*, Green; *Asaphus megalopthalmus*, Troost; *C. latifrons*, Bronn.)—This species in America as in Europe, is one of the most widely spread, principally in the Devonian system. We do not know it personally lower; nevertheless we have seen specimens of it coming from Gaspe (New Brunswick), a locality which to judge from other fossils, appears to be upper Silurian, and Mr. Conrad has cited it also in the Delthyris shales, (No. 15.) Nothing is more common, on the contrary, than this trilobite in the Devonian system as we limit it. It occupies principally the lower parts from the Schoharie grit to the Hamilton group. In the state of New York it is at the deposition of the extensive shales of the Hamil-

* [This species is described as P. *callicephala* in the Palæontology of N. Y., vol. i, p. 247.—J. H.]

ton group, that it takes its greatest development, while in the states of Ohio and Indiana where these shales are wanting, it is found abundantly in the limestones which form the upper part of the cliff limestone.

Localities.—Lewis' creek, Charlestown Landing (Indiana); Cacapou, near Hancock (Va.); Gaspe (Canada); Schoharie, Moscow, (New York.) In Europe as in America, the *P. macropthalmus* is rare in the Silurian system, while it is very abundant in the Devonian beds of the Eifel. In Russia it is found only in the Devonian system of the Altai.*

Cryphæus calliteles, Green.—This species is so similar to the *Phacops stellifer*, Burm., that it would, perhaps, be proper to unite them, and at all events, it is impossible to leave them in two distinct genera. If we retain the genus *Cryphæus*, we should place in it that small division of *Phacops* having long spines on the tail, and which comprises only two species, *P. arachnoides* and *P. stellifer*.

The *C. calliteles* is proper to the Hamilton group, and has been collected by Mr. Marie Rouault in Brittany in the limestones and shales of Gahard which are its equivalent. The *P. arachnoides* and *stellifer* are equally peculiar to the Devonian system of the Eifel.

Bumastis barriensis, Murch.—Characteristic of the contemporaneous beds of Niagara and Wenlock. It occurs at Lockport, (New York,) and Springfield, (Ohio,) in the magnesian limestone where it is associated with the *Pentamerus oblongus*. In the metalliferous region of Illinois and Wisconsin, it is found in general also at the base of the upper stage of the Silurian system; nevertheless we saw at Galena a specimen in the blue limestone, with species of the lower Silurian stage.

Homalonotus delphinocephalus, Green, sp.—This species, characteristic of the Niagara and Wenlock beds, occurs at Lockport and Rochester. It is necessary to unite with this species the *H. atlas*, *giganteus*, and *herculaneus* of M. de Castelnau.

Cheirurus insignis, Beyr.—This species of which we have the head well characterized, has been discovered by Mr. Troost in Perry county, (Tennessee,) and by us in the siliceous limestones of Chicago, (Illinois.) In these two points it belongs to the upper Silurian stage, and occurs in beds which we consider as

* [We are not prepared to agree with M. de Verneuil in writing all these as a single species. The European species presents differences of character which separate it from all the American forms, and that from the Delthyris shaly limestone of New York, and that from the Schoharie grit are totally distinct species, while that in the Hamilton group is unlike either of them. The one in the Schoharie grit has a row of short spines down the back, but usually being preserved as casts, this character is overlooked and the general form relied upon. These differences, between American specimens, and between American and European, will be more fully detailed in the Palæontology of New York, vol. ii.]

higher than those which contain *Pentamerus oblongus*. In Bohemia, according to Mr. Barrande, the *C. insignis* occurs in an analogous position, that is to say, in the middle division of the upper Silurian stage.*

Sphærexochus mirus, Beyr.—This very remarkable species is found at Springfield, Ohio, and at Madison, Indiana. At the first locality it is associated with the *Pentamerus oblongus;* in the second, it is found at the summit of the great cut through which the railroad passes in the limestones which are at the junction of the two great stages of the Silurian system.

In Bohemia it is also at the base of the upper Silurian stage that this species has been discovered. The museum of Dudley possesses a specimen found in the limestone of that city. In Sweden it descends into the lower Silurian stage, for under the name of *Calymene clavifrons*, Hisinger has figured the head of a trilobite from Furudal in Dalecarlia, which appears to us very like the species in Bohemia. Nevertheless if the figure is exact there must be some difference.

[We have copied entirely the remarks of M. de Verneuil upon the fossil fishes and trilobites common to the two countries. For the remainder of the species cited by him we refer to the table appended, mentioning only those on which we make some comments. The absolute identity of species and similarity of position of many of the trilobites in the two countries is very remarkable, and much more conspicuous than in any other family of fossils. It is no less an interesting fact, that in nearly every important stage in the geological succession which we recognize in New York, there is almost a complete representation or re-creation of the types of the earlier period. Some forms are gradually lost it is true, while the principle or idea prevailing in those may be recognized to some extent in others. We may cite some examples.

The species of Trilobites with equal or nearly equal extremities, common in the forms of Illænus, Isotelus and Asaphus, are represented only by Bumastis in the Niagara group where this form ceases. The genus Lichas which first appears in the Trenton limestone, appears in the Niagara group in the form of the large and beautiful *L. Boltoni*. A very similar species occurs in the Delthyris shaly limestone and a fourth in the Corniferous limestone. In these four distinct and widely separated stages, the type is easily recognizable even from fragments, and the spe-

* [The head of this Trilobite has been found at the base of the Niagara or upper part of the Clinton group at Lockport, and in the shale of the Niagara group at Rochester. This fossil is clearly a species of the genus Ceraurus of Green, which name has precedence over that of Cheirurus. The *C. insignis* as it occurs in New York, bears much general resemblance to the *C. pleurexanthemus*. The latter must be regarded as the typical form of the genus.—J. H.]

cies of the Niagara group and that of the Delthyris shale have been regarded as identical.

The same observations apply with almost equal force to the different species of Ceramus. The type of Phacops appears in the Trenton limestone in the species P. Dalmani. In subsequent deposits this type is numerously represented, and the forms appearing in successive stages have not always been recognized as distinct species, though actually different.

This truth applies with equal force to other classes, and though the forms are less conspicuous, it becomes equally important to recognize their differences or agreement. The earliest type always better enables us to carry forward the idea in successive periods, and to refer varieties of form or species to a standard, than to make ourselves acquainted with the subsequent forms which have reference to that type.

I have given in the succeeding remarks some observations on several species of fossils cited in this paper, in instances where we think the original may lead to erroneous opinions, or where any new facts of importance have transpired.

Bellerophon bilobatus.—Since the publication of the first volume of the Palæontology of New York, two or three very imperfect specimens of a form undistinguishable from B. bilobatus, have been found by Col. Jewett in the Clinton group at Lockport.

Subulites elongata.—A second species of this peculiar genus has recently been obtained near Watertown, Jefferson county, New York.

Grammysia hamiltonensis [DeVern.], (*Pterinea bisulcata*, Conrad, Ann. Geol. Report, N. Y., 1838, page 116. *Cypricardites bisulcata*, Ann. Report of 1841, page 52.) This shell is very properly separated by M. de Verneuil from any previously established genus; but the name of the species, according to established usage, must give place to that proposed by Mr. Conrad. The species is remarkably abundant and widely extended in the Hamilton group, and the figures of M. de Verneuil are very characteristic.

Terebratula reticularis, Lin., (*T. prisca*, Schlot., *T. affinis*, Sow.)—It is difficult to believe that the great variety of forms which we find from the Clinton group to the Chemung group inclusive, are all of this species, though presenting a strong similarity of character. We may yet hope that the discovery of separated valves will enable us to detect characters, which will prove the well defined forms of the Niagara group and those of the Hamilton group to be distinct species.

Pentamerus oblongus, Sow.—This species though found in the United States at the base of the upper Silurian stage, is regarded in Europe as belonging to the lower stage. There can be no question as to its uniform position in this country, and as we have

elsewhere said, we believe the beds containing this fossil in Europe will be found to belong to the upper stage. Thus far no species of Pentamerus is known in the lower Silurian stage, and we feel much confidence in the theoretical views which we entertain regarding the progressive development of types which would not admit of such a form in the lower stage.

Spirifer sulcatus, Dalm., (*Delthyris decemplicata*, Hall).—"This species occupies at Lockport the same position as in the island of Gothland." We have no doubt of the identity of our species with the European one after having had an opportunity of comparing authentic specimens.

S. crispus, Dalm., (*D. staminea*, Hall).—This species which is frequently confounded with the last, is entirely distinct, and is also identical with the Swedish species.

"*S. bilobus*, Linn., sp. (*S. sinuatus*, Sow., *S. cardiospermiformis*, His.: *Delthyris varica*, Conrad.)"—"This remarkable little species of the Wenlock stage is found in the equivalent rocks of Rochester, New York; but it is even more abundant in more recent beds, that is to say, in the *Delthyris* shales; it is to this one that Mr. Conrad has given the name of *D. varica*, which is distinguished from the other by a shorter hinge, by its general form being more enlarged and by a more profound sinus. A careful comparison of the two varieties with the *S. bilobus* of Europe induces us to reunite them."

We regret to feel compelled to differ from the opinion of so careful an observer as M. de Verneuil, but in this case we cannot hesitate to pronounce the two varieties of form in question, very distinct species. The Niagara species is doubtless identical with the Swedish one, while the other differs in being much larger and having both valves convex. Of the *D. varica* we have some thousands of specimens and even in the smaller ones, corresponding to the Niagara species in size, we find a marked contrast. The differences between these two species of the two stages is equally as great in proportion to the size of the specimens, as between the *Delthyris crispa* of the Niagara group and the *D. cycloptera* of the Delthyris shale, or between *D. sulcata* of Niagara and *D.* —— of the Delthyris shale.

Orthis hybrida, Sow.—The species occurring in the Niagara group and the one in the Delthyris shale are quite distinct, as we shall be able to prove by specimens and figures.

Favosites gothlandica, (Goldf. sp.)—We are not confident as to the wide geological range of this species, though it probably occurs in the Silurian and Devonian systems. We have nevertheless been unable to find a characteristic specimen in the Clinton and Niagara groups; those which we have long referred to it proving to belong to an entirely distinct genus. There is however a species of Favosites in the Niagara group, but it occurs in small irregular forms and it is not easy to decide its specific relations.

Catenipora escharoides.—This species in all its varieties of form is confined to the Clinton and Niagara groups of New York. I have taken some pains to ascertain the facts in relation to the Caledonia specimen cited by Verneuil, as received from Col. Jewett. It proves to have been obtained at a place even higher in the series than Caledonia, but the mass was a transported block of the Niagara limestone, such as are often found either at the base of the terrace formed by the Corniferous limestone or in the valley along the base of the Hamilton group; the latter position is the one in which the specimen in question was obtained.

It is not for a single species that we care to contend, neither its identity nor geological position, but the integrity of the whole system depends on maintaining the truth under all circumstances. The views I advanced some years since in reference to the geological position of the Catenipora have never been controverted by the production of a specimen from any higher position than the Niagara group.

There are among the list given by M. de Verneuil, several other species the identity, and geological range of which we feel disposed to question, but at present we have indicated only those of which there can be no doubt. We feel conscious that this subject may be viewed and treated in two extremes. On the one hand there are, and have always been, those who consider the species of different beds as identical when they bear some general resemblance to each other; on the other hand there are a few, who seeing the evil of this course have gone to the other extreme, and regard *a priori* species from different beds as distinct. We confess that we have more confidence in the latter than the former course, though we cannot fully agree with the practice. We do not hesitate to say, that a difference between similar forms from different geological stages is to be regarded as of more importance than when the specimens are from the same bed. It not unfrequently happens that these slight obvious differences of specimens from different beds, prove to be connected with other and more important differences which were not obvious on first inspection, and which are often developed by an examination of the interior of the fossil.

In these respects M. de Verneuil pursues an intermediate course, with, as it appears to us, a leaning towards the previous opinions and views of geologists and palæontologists, which his own acute powers of observation so often prove to be erroneous or partial. In this place we may mention too the practice of referring to previously established genera all the fossil types. This has been so much the practice, that little progress has been made in just discrimination till within a few years past. To show how far this opinion or prejudice has prevailed, we need cite only the genus Productus which for a long time included all fossils of this

general form, and even others more remotely allied. We now have *Leptæna*, *Chonetes* and *Productus*, while the genus *Orthis* includes other forms previously referred to *Productus*. Still another genus of the Leptænidæ may be constituted, and we shall have a more natural subdivision than at present, each one possessing characters of important and peculiar value.

While M. de Verneuil recognizes and clearly establishes the genus *Chonetes*, we are surprised that he should unite all the Terebratuloid forms in the genus Terebratula, when there is ample room for subdivision. We believe, however, that we understand the motives of M. de Verneuil; and we cannot but admire the manifestation of this most scrupulous and sensitive reverence for the labors of his predecessors.

There is likewise in other families much room for improvement in establishing genera and applying characters, in more strict reference to their true meaning. This, perhaps, cannot be done entirely until the true principle of progression among types is fully established, or better understood than at present.

As American geologists, we are all much indebted to M. de Verneuil for giving us this sketch of his examinations in this country. Coming fresh from his extensive explorations in Russia and the northern parts of Europe, with Sir R. I. Murchison, and with an intimate knowledge of other portions of the continent, and all that had been previously done in the investigation of the palæozoic strata, no other person could have presented so clear and perfect a coup d'œil as we have in this paper.

In concluding this subject, two points of interest present themselves as of special importance, namely, the line of demarcation between the Silurian and Devonian systems, and that between the Devonian and Carboniferous systems. We have space only to glance at the first of these. It appears clearly established, judging from the facts advanced and opinions expressed by M. de Verneuil, that the horizon recognized in Europe as the base of the Devonian system, finds its parallel at the base of our upper limestone series of the Helderberg, or at the bottom of the Schoharie grit. The Oriskany sandstone must remain for the present debatable ground. This horizon, when traced westward, passes through the cliff limestone, leaving its lower part, which is a continuation of the Niagara group, in the Silurian system, and the upper part, corresponding to our Onondaga and Corniferous limestones, in the Devonian system. Thus it would appear that we have all doubts removed as to what is recognized as Devonian in Europe, and however disposed we may feel to question the propriety of such subdivision, we are satisfied to know its recognized limits.

It is not a little remarkable, however, that there still exist so many real causes for difference of opinion in relation to the limits

of the Silurian and Devonian systems. In the second volume, part I, of the Memoirs of the Geological Survey of Great Britain, several species of what are termed *Orthonota*, but really, as we think, *Grammysia*, are figured from the Silurian strata of Great Britain, while others of *Mytilus* are very similar, if not identical, with species from the Hamilton and Chemung groups of New York. Thus far I have never seen, in the State of New York, nor in any of the western states, a single species of bivalve of the character of *Grammysia*, below the Corniferous limestone, or even below the Hamilton group. These cingulated or obliquely furrowed and banded bivalves, are regarded as unerring guides to the eye, of the formations; and adopting the view of M. de Verneuil, as to the horizon of the Devonian, they are all above the Silurian system. There is still some mystery to us, on this side of the Atlantic, how the Ludlow and Wenlock rocks should contain fossils so very analogous to our Hamilton and Chemung fossils, and still be of Silurian age, while many of the Devonian Brachiopods of England are found mingled with these fossils in the groups referred to here. If it be true that these fossils are of Silurian age, and the line of division assumed here be the true one, then in this country we should have, above our upper *Pentamerus* limestone, a group of Silurian strata producing fossils analogous to those described by Mr. Salter. For, notwithstanding there may be a want of identity in species, the development of types has always proceeded *pari passu* with the successive depositions over the whole globe, so far as our knowledge extends.

Taking another view of the case, however, and regarding our Hamilton and Chemung groups as equivalent in age to those groups of England from which such similar fossils are obtained, we must carry the Silurian limit to the base of the old red sandstone, which, indeed, appears to be the natural and true horizon of its upper termination. This view we think is sustained when we regard the totality of the species, and the palæontological evidence on which we found subdivisions. For the whole United States, this would be attended with less difficulty than any other mode of subdivision. Still we must regard the fact of the introduction of the genus Productus, and some other forms allied to those regarded as Carboniferous types, at the time of the corniferous limestone; and the increasing number of these forms, as we ascend, till the higher part of the Chemung group bears a close analogy with the yellow sandstones of Ohio and Indiana, which are regarded as of carboniferous age.

These remarks are made in order to call attention to the fact, that there is still room for doubt and discussion on this point, and that on palæontological evidence, there is no well-marked line of separation, separating what may on one side be termed Silurian, and on the other, Devonian.]

ART. XXI.—*General Rule for Involution and Evolution by Logarithms;* by J. L. RIDDELL, M.D., Professor of Chemistry.

HAVING recently had occasion to use decimal exponents, in the involution of decimal quantities; and not finding in any mathematical works at my command, any directions or rules therefor, sufficiently explicit, it became necessary to seek out *de novo* some certain and convenient plan of operation.

To the following method, among several, I give preference; and I offer it for publication, (though I cannot flatter myself that it will be found by mathematicians to possess novelty,) because I am sure it may prove convenient and reliable to students and others, especially in the management of decimal quantities with decimal exponents.

The truth of the method must, upon inspection, be so obvious to mathematicians, as to render an accompanying demonstration unnecessary.

Precaution.—Let the numerical quantity to be involved, and also if convenient the exponent, be expressed in integers or decimals, or both if necessary.

General Rule for Involution and Evolution.

Take the decimal part of the logarithm of the numerical quantity from the tables, and make the index equal the number less by 1 than the number of places in the quantity from the first significant figure or place on the left, to the last figure on the right. Multiply this logarithm by the exponent, and from the product, subtract the product of the exponent into the number of decimal places in the quantity; the remainder will be the logarithm of the root or power sought, with its appropriate index and sign.

In order to express this rule by symbols,

Let Q = the numerical quantity to be involved or evolved.
Dec log Q = the decimal part of the logarithm of Q.
R = the root or power sought.
M = the exponent.
N = number diminished by unity of integral and decimal places in Q, from the first significant figure on the left, to the last place on the right.
D = number of decimal places in Q.

The formula then becomes

$$M(N+\text{dec log } Q)-MD=\log R.$$

Example 1.—Let it be required to raise 0·111 to the 0·0111 power.

Then dec log Q = ·0457141. M = 0·0111. N = 2. D = 3.

$0{\cdot}0111\times2{\cdot}0457141-0{\cdot}0333=-1+{\cdot}8837782=\log R$, the corresponding number of which is 0·7652.

Example 2.—Raise 10 to the 4th power.

Here Q = 10. dec log Q = 0. M = 4. N = 1. D = 0.

$4 \times 1 - (4 \times 0 = 0) = 4$ or $+4$. = log of R.

Hence R = 10000.

Example 3.—Required the cube root of 0·000111.

Here dec log Q = ·0457141. M = $\frac{1}{3}$. N = 2. D = 6.

$\frac{1}{3} \times 2 \cdot 0457141 - \frac{1}{3} \times 6 = -24 \cdot 6819047 = \log R$.

Hence the cube root of 0·000111 is 0·048073.

Branch Mint, New Orleans, October 9, 1848.

ART. XXII.—*Abstract of a Series of Experiments on Diamagnetism;* by H. C. ŒRSTED of Copenhagen.*

AT the session of the Royal Society of Science at Copenhagen on the 30th of June, (1848,) I presented the results of researches which I had made in diamagnetism, and I gave a report of the same in the Comptes Rendus of the Society. In the recess of this Society I have continued my researches and obtained many new results. As the memoir will not appear in the Society's Transactions in many months, I have decided to give an abstract of my results which can be communicated to my foreign friends.

My researches relate to the celebrated discoveries of Dr. Faraday, and to the developments which these have received from the German philosophers.

Dr. Faraday encountered in his experiments with his great electro-magnet, a class of bodies which are repulsed by the two poles of the magnet. This repulsion had been for a long time well known in the case of two or three substances, but the researches of the illustrious English philosopher have given to this fact a generality and an importance which has rendered it the object of attraction by all men of science. M. A. Brugmanns had as early as 1778 noticed that bismuth was repelled by the two poles of the magnet. M. Becquerel (the father) observed this repulsion anew, as relates to bismuth and antimony. Dr. Faraday found that his great electro-magnet produced this repulsion upon almost all bodies which it did not attract. He discovered also that bodies having unequal dimensions of length and breadth, when thus repelled under the influence of an electro-magnet, took a position perpendicular to that which an attractive body would take under the same circumstances. This is the property which he calls *diamagnetism.*

M. Reich of Freiberg, well known by his beautiful experiments upon the lateral deviation in the descent of bodies which fall to the

* Translated for this Journal from the Ann. de Ch. et de Phys., Dec., 1848.

earth from a great height, applied to the discovery of diamagnetism the observation, neglected by other philosophers, that the two poles of the magnet employed together did not produce upon the body a repulsion equal to the sum of the repulsions effected by each, but equal to their difference; to the end—that their united effect would be null when their forces are equal. At the same time he made some experiments which seemed to indicate that the pole repelling a diamagnetic body, produces in the adjoining parts of another diamagnetic body a magnetic force like its own. M. Wilhem Weber confirmed the idea of M. Reich by his learned researches, and showed that diamagnetic bodies receive by the influence of an electro-magnet, a transversal magnetism having two poles, but so disposed that each of them has the same sort of magnetism as the nearest pole of the electro-magnet. M. Poggendorff contrived other experiments of a decisive character that have the advantage of proving the idea in an easy manner; and M. Plucker adds also a new experiment which increases if not the certainty of the result at least the facility of arriving at it.

These are the labors which served as a starting point for my researches. I used for my experiments the great electro-magnet of the Polytechnic School of Copenhagen, in the form of an U, and capable of supporting 1,400 kilogrammes.* Meanwhile it may be remarked that it was not necessary to put all its force in action for these experiments; but we rarely used less than half of this force, although the greater part of them could be executed with a much more feeble power, even with one element. Each extremity of the electro-magnet carried a piece of iron horizontally which we call a polar-piece. These polar pieces serve to give to the action of the electro-magnet a horizontal direction. It is between the two perpendicular faces situated vis-a-vis to one an-

* I here conform to the ordinary manner of indicating the force of a magnet; although uncertain, it has been proved upon this electro-magnet and communicated to the Royal Society in their session of 17th Dec., 1847. In these experiments the weight which the electro-magnet was capable of supporting, was tried when its poles were armed with different masses of iron. To certain limits the supporting power increases very nearly in proportion to the mass of the armature. But that which most merits our attention is that the force of the electro-magnet, expressed in weight, does not bear the same ratio to the electro-motive power of the galvanic machinery whilst the armature is in contact with the electro-magnet and when at a distance from it. In contact, the mean power of each galvanic element was 712·5 kil., but two elements united gave only 0·72 the sum of power of each element, three elements united gave only 0·48, eight 0·26, sixteen 0·125, the sum of each power; to the effect that sixteen elements were only double the power of one element. At the distance of 1·33 mm. the effect of one element was only 0·178 of that of the same element, in the case of contact; but the product increases quite differently with the number of the elements. Sixteen elements give here four times the product of one alone. At the distance of 2·225 mm. the product of one element was only 0·051 of that produced in the case of contact; but sixteen elements gave 9·4 times the product which one alone gave. These researches which demand much time will be pursued as soon as my other occupations will permit.

other, that the diamagnetic body is made to oscillate. These faces we call polar faces. In all cases where I have not indicated exceptions I have used the rectangular pieces: at the commencement of my experiments I made use of cylindrical pieces, but this form is less convenient for discovering all the circumstances which ought to be taken into consideration in these researches. A diamagnetic needle suspended horizontally between the polar faces takes, as is known, the situation called *equatorial* which is parallel to the polar faces, but if it is raised a little above the edge of the polar faces, it takes a direction perpendicular to the polar faces prolonged. This position is at the same time the axial; but we see from what follows, that it is the perpendicularity of the polar faces which is here to be regarded. This phenomenon presents itself with remarkable readiness, which renders this experiment very convenient for many diamagnetic researches. On turning away the needle from its position perpendicular to the faces, it oscillates back again. Its directive force goes on diminishing as it is raised above the polar-pieces.

This experiment has been made with many diamagnetic bodies, with bismuth, amber, nacre of pearl, the shell of the tortoise, with alabaster, quills, sulphur, and pit-coal. The variation of the direction observed in these experiments, is lost in proportion as the polar faces are removed from one another. At a distance of seventeen millimetres the effect was still well marked, but it is much stronger at short distances. When the distance was diminished so far that the diamagnetic body could not enter between the polar faces, that is to say, in a position perpendicular to the polar faces, the part of the effect taking place above the polar faces showed itself with much force. When the diamagnetic needle is suspended above the upper edge of one of the polar faces, it takes equally the position called axial, perpendicular to this edge, but with less force than when under the influence of the two faces. On examining the position which the needle takes above the other edges of the polar-piece, it is found to take everywhere a position perpendicular to the edge, to whose influence it is exposed. In the case where it is exposed to the action of two edges at the same time, it takes an intermediate position.

Above the edge of a wedge of iron placed with its base upon one of the poles of the electro-magnet, the needle took also a position perpendicular to this edge. Upon a cylindrical polar-piece, the needle with its centre above the edge of the polar face, places itself perpendicularly to this face; but when at some distance from the edge, it turned and took a position perpendicular to the line which might be traced parallel to the axis on the highest part of the cylindrical surface. When a perforated cylinder is taken for a polar-piece, if the diamagnetic needle be made alternately to descend and rise parallel to the polar face, we

find that this needle quits its parallel position and takes an axial one as soon as it is placed opposite the holes of perforation. For this experiment I use a needle of bismuth of only sixteen millimetres in length. In using the two polar-pieces together, you produce the same effect in a much greater manner.

When the diamagnetic needle is suspended between the polar faces, it has, according to the experiments of the German investigators already cited, the magnetic poles in a transverse direction disposed in such a manner that the magnetism of each side is of the same nature as that of the nearest pole of the electro-magnet. The easiest method of confirming this is that of Plucker, who introduced between the polar faces and parallel to them, a small bar of iron separated from the faces by some non-magnetic body. Since the sides of this bar receive influence by magnetism opposite to that of the nearest face, and also each side of the needle has the same magnetism as the face nearest to it, the needle, now held by two forces, oscillates with much greater rapidity than when under the influence of the polar faces alone. When the diamagnetic needle is raised above one of the polar-pieces, so as to change its direction, its magnetic poles change their place at the same time. At the beginning I had been led into error by many phenomena, which in the novelty of the researches seemed very complicated, but now appear very simple since the law is found. At the commencement I believed that the diamagnetic needle above the polar-piece, had in each extremity magnetism opposite to that of its neighboring polar-piece; for the lower part of a bar of iron influenced by the piece, repelled the extremity of the needle which was above the piece. I have found this effect not only in placing the repelling pole of iron near each side, but equally above and below. Yet the later experiments have refuted the conclusions which I had drawn from the first. I have found that a piece of iron which is not very small, receives from the polar-piece that acts upon it, a magnetic force quite strong for repelling the diamagnetic matter of the needle, in spite of the poles which it has received by the influence exerted upon it by the electro-magnet.

For discovering the diamagnetic poles in this case, it is necessary to employ very small pieces or plates of iron; generally they should be but two or three grammes in weight. In order to manage them more easily, I have attached them to plates of zinc or pieces of wood. By this means I became at last convinced that the lower part of the diamagnetic needle suspended above the polar-piece had the same magnetism as that, and that its upper part had the opposite. In experiments for this object, I have made use of a thin plate of iron of this form ☾, attached to a bit of wood.

When this plate is placed upon the polar-piece, it has the same magnetism in its upper part as the polar-piece, and in the lower part the opposite. When the opening of this curve is opposite to

the needle, it attracts it; but when its upper part is below or its lower part above, it repels it. When the needle is so suspended upon one of the polar-pieces that the prolongation of one of the perpendicular faces cuts the needle into two parts, we find that the diamagnetic poles produced by the electro-magnet extend beyond that part which projects over the upper surface of the piece. In these experiments made with a needle of bismuth of fifty-six millimetres, this effect extends hardly fourteen millimetres. When the needle was cut in two equal parts by the perpendicular faces prolonged, we found that the extremity of the needle most remote from the polar-piece was without polarity. When the electro-magnet was armed with two polar-pieces, placed at a distance of forty-eight millimetres, I found that the same needle had diamagnetic poles in all its parts. The half of the needle which was turned towards the north pole, had northern magnetism upon its lower edge, and southern upon its upper edge; the other half of the needle had by the influence of the southern pole, the magnetism of this pole upon its lower edge and of the northern upon its upper edge.

There is then an opposition of magnetism in the two halves of each edge taken separately, and in each half between the two edges, the upper and lower.

When the diamagnetic body is made to oscillate between the polar faces, we find that it makes its vibrations with much more strength when it is nearer one edge of this face.

In an experiment in which the electro-magnet was acted upon by sixteen of Bunsen's galvanic pairs, and where the distance of the polar faces was six millimetres, a needle of bismuth being at an equal distance from the upper and lower edges of these faces, made in thirty seconds twenty-five oscillations; but on a level with the edges, it made in the same time one hundred oscillations. Above the polar-pieces in an axial position, the needle made only nineteen oscillations in the same time. These experiments have been sufficiently repeated and varied to give perfect certainty to what is here announced, but the researches have not yet been pushed far enough to deduce an exact numerical law.

When a horizontal needle of bismuth is suspended to the extremity of a balance by a thread of silk, in such a manner that it can descend or rise, the needle is much more strongly repelled when it finds itself near one of the edges of the polar faces. This repulsion causes the needle to rise when it is near the upper edges, and to descend when it is near the lower edges, and in the intermediate position it neither mounts nor descends. When it is suspended above the polar-pieces and consequently in a direction perpendicular to the polar faces, it is still repelled though much more feebly than when in the equatorial position.

We have hitherto known only the diamagnetic effects in bodies which are repelled by the electro-magnet. My experiments have

shown that a similar effect is produced in most bodies which are attracted by the two magnetic poles; and these constitute a new species of diamagnetic bodies. We therefore distinguish two classes, *repelling* and *attracting* diamagnetic bodies.

A needle made of a body capable of being attracted by the magnet, but of which the magnetism is not of the same nature as that of iron or nickel, suspended between the two polar faces of the electromagnet, takes as is known, the position called by M. Faraday, axial; but if made to rise above the upper edges, or descend below the lower edges of the polar faces, it takes an equatorial position.

The bodies in which I have already found these properties are platinum, palladium, iridium, titanium, an alloy of 0·825 tin, 0·024 of bismuth, 0·108 of iron; brass, argentan, charcoal, coke, (the pit-coal is believed to belong to repelling diamagnetic bodies,) obsidian, native carbonate of iron, attracting glass, Prussian blue, and the solutions of iron. In the greater number of these bodies the magnetic poles which are obtained during the influence of the electro-magnet, are lost as soon as the influence ceases: notwithstanding they betray themselves when the poles of the electro-magnet are suddenly changed; for then many of these bodies turn half a circle, as a magnetic needle would; others do not turn entirely, but oscillate enough to show their tendency to change positions. But some attracting diamagnetic bodies, such as a piece of iridium in my possession, charcoal or coke, retain for a longer time the poles which they have acquired. The experimental researches upon the phenomena of these bodies are complicated by this duration of polarity, but they will probably lead to the discovery of the relation which exists between magnetism and diamagnetism.

When a needle made of an attracting diamagnetic body is suspended above the upper or below the lower edge of the polar-piece, it takes a position parallel to this edge. In this parallel position, which can as well be either perpendicular to the magnetic axis of the polar-piece, or parallel, or in any other position conformable to the figure of the polar-piece, the disposition of the magnetic forces in the needle is transversal, as in a repelling diamagnetic body, but with this difference, that the lower part has a magnetism opposed to that of the polar-piece, and the upper part to that of the same nature.

I have not yet succeeded in putting iron itself into a diamagnetic state. An iron wire of only one-tenth of a millimetre in diameter, takes an axial direction as well above as between the polar faces, and that with a force which seems nearly sufficient to break a silk thread. To vary this experiment, I put into a quill (which is repellant) a fragment of the same wire, that was only two millimetres long; but this presented the same effects as when the iron was alone. The same effect is obtained by repla-

cing the wire by a very thin particle of iron filings; but upon introducing in place of the iron a piece of straw which had been plunged into a solution of iron, the diamagnetic effects were those of attracting bodies. Nickel gives the same results as iron. Thus iron and nickel ought to be called, in a strict sense, magnetic. Some other bodies may be of the same kind; I presume cobalt is.

There is then a decreasing magnetic progression which includes magnetic bodies properly so called, diamagnetic attracting bodies, and diamagnetic repelling bodies. The magnetism of the last may be considered as negative, if the magnetism of iron and of attractive diamagnetic bodies be considered positive.

The effect which the polar faces exert upon the attractive diamagnetic bodies is, as regards a relation to the repellants, stronger when the body is placed nearer the upper or lower edges than their intermediate parts. A piece of attracting glass, twenty-seven millimetres long, suspended between the polar faces, at a distance of twenty-nine millimetres, in such a manner that the ends of this needle were not farther from the polar faces than one millimetre, was oscillated each time for thirty seconds. At an equal distance from the upper and lower edges it made only 4·5 oscillations in thirty seconds; but on a level with the polar faces, it made 19.

When the polar faces are at this distance, the needle does not take the equatorial direction when it is suspended above their edges. At a distance of 4·5 millimetres, it made only 5·5 oscillations. At a distance of 13·5 millimetres, it made only 2·5 oscillations. On approaching the polar faces even to three millimetres, the needle which now could not take the axial direction between the faces, still showed all its tendency to take that position; but raised at a distance of two millimetres above their edges, it took the equatorial position, and made 18 oscillations in thirty seconds. At a distance of three-tenths of a millimetre it made 35 oscillations. At the nearest point at which it could escape contact with the polar-pieces, it made 45 oscillations.

Diamagnetic bodies, therefore, repellant as well as attractive, have their oscillations more numerous in a position parallel to the polar faces, than in a perpendicular one. It is to be remarked here, as has already been done upon another series of experiments, that the determinations of numbers have not been sufficient to give the exactness necessary for calculating their laws.

I have lately made some experiments upon the influence of heat upon diamagnetic bodies. These experiments have not yet been sufficiently numerous; but they show that some attracting diamagnetic bodies pass into the class of repellant diamagnetic by an increase of temperature. The only body which has shown me this effect in a high degree, is brass. My analogous experiments upon other bodies are not yet sufficiently decisive to be reported here.

ART. XXIII.—*Abstract of a Meteorological Journal, kept at Marietta, Ohio, Lat.* 39° 25′ N., and Long. 4° 28′ W. of Washington City; by S. P. HILDRETH, M.D.

MONTHS.	THERMOMETER.							BAROMETER.		
	Mean temperature.	Maximum.	Minimum.	Fair days.	Cloudy days.	Rain and melted snow. In. and 100ths.	Prevailing winds.	Maximum.	Minimum.	Range.
January, - -	36·—	60	3	17	14	2·04	W. N. & S.	29·90	29·—	·90
February, -	37·—	67	17	16	13	1·33	N. W. & S. E.	29·70	29·05	·65
March, - -	39·33	83	5	16	15	3·00	W., N. & S.	29·80	29·10	·70
April, - -	53·78	85	24	25	5	1·38	S., N. & S. W.	29·80	29·30	·50
May, - -	64·75	87	37	18	13	5·66	S. & N.	29·58	29·20	·38
June, - -	67·66	89	43	23	7	3·25	S. & N.	29·58	29·25	·28
July, - -	69·66	86	50	16	15	8·05	S. E., S. & S. W.	29·55	29·10	·45
August, - -	70·—	88	53	19	12	4·86	S. E. & S.	29·60	29·25	·35
September, -	59·33	82	34	23	7	1·08	S. & N.	29·63	29·10	·53
October, - -	51·66	76	32	16	15	3·09	N., S. & S. E.	29·68	29·05	·63
November, -	38·—	62	22	14	16	2·86	W. & N.	29·70	29·05	·65
December, -	42·66	69	20	8	23	6·58	S. W. & N.	29·93	29·05	·88
Mean for year,	52·50					43·18				

THE mean temperature for 1848 is 52°·50, which is very near the usual degree of heat for this place, and accords with that of our wells and springs, which are allowed generally to be correct tests of the mean heat of the year. The mean indicated by the thermometer varies a degree or two in different years, owing to very hot summers, or extreme cold winters; rising as high as 54° for some years, and sinking as low as 50° for others, forming quite a variety in a series of years.

The amount of rain and melted snow was forty-three inches and eighteen hundredths, while in 1847 it was fifty-two inches and thirty hundredths, this being the year of the great flood in the Ohio river, in the month of December. Heavy rains attended the winter solstice this year, as they almost invariably do at this period, every year; wet weather is much more certain at this period than at the equinox.

The mean temperature for the winter months was 36°·11, for the spring 52°·59; summer 69°·10, and for the autumnal months 49°·70.

The year which has just closed has been rather remarkable for its equable temperature. The greatest cold was at 3° above zero, on the tenth of January; and the greatest heat at 89°, on the 27th of June. In July, August and September, it seldom rose above 80° in the hottest season of the day, doing so only on eighteen days; while in the year 1846, it rose above this point on fifty-nine days, standing at 91° and 92° several

times; showing great inequality in the temperature of our summer months.

The crops of grain and fruit were generally very good, fully equal to those of any previous year, especially in the production of apples and peaches. The growth and ripening of melons was much retarded by the coolness of the summer; while the excessive rains of July, over eight inches in depth, not only rotted the roots of the vines, but greatly injured the grapes, causing a mildew and blight on the foliage and fruit. Apples were never finer, and that portion of Washington county bordering on the Ohio river furnished twenty-three thousand barrels for the markets, above and below Marietta. The soil and climate are admirably adapted to the growth of the apple, and no portion of the United States can show more perfect fruit than that seen in the orchards of the Ohio valley.

The mean of the spring months was fifty-two degrees and fifty-nine hundredths; the heat of May being somewhat greater than in some years, exceeding that of 1847 by about three degrees. Spring frosts were less destructive to fruit blossoms than common, and where they prevailed did not kill the germs, as they do in some years. A smart frost on the 15th day of April, when the plum and pear were in bloom, and the peach had not yet shed its petals, although the temperature fell to 28°, did not much injure the fruit, as full crops of all but cherries were produced. This variety of fruit having been very abundant the year before, may account for its failure, as trees which have rested one year will bear much more frost the next, having acquired vigor by the period of rest, and more able to resist the action of cold than trees somewhat exhausted by a previous full crop of fruit.

Floral Calendar for 1848.—February 20th, Garden Crocus in bloom, and honey-bees at work on their blossoms.

March 24th, Garden earth so dry as to admit of working, and the seeds of various esculent vegetables were planted. 29th, Hyacinth in bloom. N. B. In this month snow fell to the depth of three inches, on the 3d and 9th. On the morning of the 4th, the thermometer fell to 5° above zero. Peach-trees were quite forward, showing the rich color of the unopened petals, the size of a small pea. It was feared that this great depression of temperature would destroy the vitality of the embryo fruit; but as the germ was protected by the leaves of the unexpanded flower, it escaped unharmed. It is a wonderful provision of nature to protect the fruit bud, although far advanced in its progress towards maturity.

April 1, Hepatica triloba in bloom; this is usually out in March, as early as the 15th or 20th. Peach nearly in bloom. Apricot in blossom, but killed by the cold in March; 5th, Peach

in full bloom; 6th, Sanguinaria canadensis; 8th, Primrose and violet; 10th, Imperial gage; 11th, Cherry and pear; 13th, Ranunculus sylvan; 14th, Dodecatheon media; also Pyrus japonica. N. B. This shrub is two weeks later than common in blooming; 16th, June berry; 17th, Portugal quince; 18th, Apple-tree; 19th, Some snow fell—half an inch—on the morning of the 20th; thermometer at 24°; 20th, Judas-tree; 22d, Chickasaw plum. N. B. Put out dahlias, tuberoses and lilies, in the open ground. 23d, Common quince in bloom; 24th, Yellow violet, and Uvularia; 25th, Harebell; 27th, Buckeye; 28th, Garden Ranunculus; 29th, Cornus florida.

May 1st, Hickory-tree in bloom; 2d, White walnut—Apple shedding its blossoms; 3d, Papaw—garden tulips in full bloom; 4th, Black walnut; 15th, Yellow moccasin flower; 16th, Purple mulberry; 25th, Hovey's strawberry ripe; 27th, Osage orange in bloom.

June 1st, Frost this morning in the uplands, back from the river, on white-oak lands—here the thermometer was at 48°! On the 7th and 8th of this month, there was light frost on the uplands, three or four miles back—thermometer at 43° at sunrise. 12th, Russian cucumber fit for the table, grown in the open ground, protected in April by a small box with glass; 13th, Frost this morning on the outskirts of the town—thermometer at 40; the night being clear, the radiation of caloric was rapid. 14th, Purple mulberry ripe; 19th, Catalpa in bloom; 21st, Yellow and red Antwerp raspberry ripe; 26th, Hay harvest begins; 29th, Wheat harvest commences.

July 1st, Early Chandler apple ripe, and Golden-drop fit for eating, but not all ripe.

The mean temperature of the summer months was 69°·10, which is quite low. In 1846, it was 71°·05. July was excessively wet, there falling over eight inches of rain. Much wheat was damaged while standing in shocks, in the field, and a quantity of hay entirely ruined.

The potato crops also suffered greatly from "the rot," which is much worse in wet seasons than in dry. Some fields were ruined by a worm in the stalk, the egg being deposited by a fly in the extremity of the stem, and working downward in the pith, it wilts and rots, destroying the tubers. It is a new enemy to this valuable esculent. Some fields were benefited by mowing off the tops of the vines, and thus destroying the worm. Indian corn, that most valuable and nourishing grain of all the cereals, flourished and grew luxuriantly. It is a plant most admirably adapted to the wants of man and beasts, growing in the United States from their northern to their most southern limits, and when ripe for harvest, remains unharmed in the field for months, to suit the convenience of the grower; while other crops are lost if

not gathered at maturity. The mean of the autumnal months was 49°·70, about three degrees lower than in 1847; while December was unusually warm, 42°·66, or seven degrees above that of 1848. It was also very rainy, being 6½ inches; raising quite a flood in the southern branches of the Ohio, and threatening to repeat the freshet of last year.

ART. XXIV.—*On a new Protractor for Trisecting Angles;* by J. H. ALEXANDER, Esq.

THE problem of *the Trisection of the Angle*, as it has always been termed, was no doubt one of the earliest to attract the efforts of the ancient geometers. At least, it is very reasonable to suppose that immediately upon the discovery of the method of *bisecting* an arc, would follow an attempt to investigate the modes of dividing it into three or any number of unequal parts or, indeed, in general to divide it in any ratio. We have no evidence to show precisely when this was first undertaken; nor has the name of any philosopher come down to us, traditionally connected with the announcement or the history of such investigation, as is the case, for instance, with the rectifying lunules of Hypocrates or the duplication of the cube of Menæchmus. But as there is one Geometer, Dinostratus, to whom has uniformly been attributed the invention of the *quadratrix*, a curve capable of being applied to the solution of this very problem (although from the loss of all writings of his, we do not know the extent of the aim with which he applied it), we are warranted in ascribing the attempts at the trisection of angles to a period at least as early as his. And as he is reported to have been the friend and collaborator of Plato, we cannot be far wrong in fixing the date not lower than 400 B. C.; and a fresh association of interest is thus connected with the problem, in considering that for 2000 years and more its terms and conditions have occupied at some time or other the thoughts of all who have devoted themselves to pure mathematics.

The problem was further piquant; because it shewed three cases admitting of solution by strict geometric construction. These are the trisection of the circle, of the semi-circle and of the quadrant. One can, therefore, appreciate the peculiarly tormenting nature of the obstacle which, after the possession of so many steps, prevented the acquisition of more, and which might seem created expressly to baffle, in what it refused, the curiosity that it stimulated in what it allowed. Of all geometrical problems, this was emphatically the *coquette*.

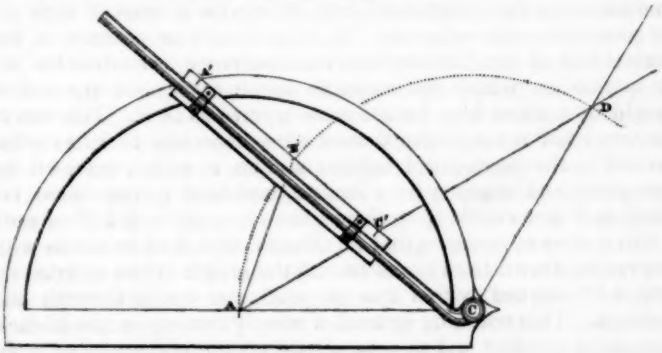
But such an epithet would be unjust, if it could apply to the individuality of the question itself; for the obstacle, in fact, lay

in the conditions prescribed for the research; and the failure is to be ascribed (if we may continue the metaphor) more to the fastidiousness of the suitors than the caprice of the object. The severe synthetic geometry of the ancients admitted only fixed points and constructions upon lines drawn from or to such points. Hence *motion*, except around a fixed point (as for instance in the description of a circle) although neither unknown nor uninvestigated in that early science, found no place in the majestic stability which the school of Plato sought to uphold. It was only in despair (or perhaps he meant it to show what he could do if he would) that Plato himself resorted to a mechanical solution in effecting the duplication of the cube. The quadratrix of Dinostratus, therefore, as well as other methods that might have been proposed, involving sections of the cone, for the trisection of an angle, was classed in the interdicted caste of *mechanical* curves (as such figures were denominated); and so failed, in the verdict of antique severity, to be admitted among the triumphs of pure geometry. Modern times, less prepossessed or more just, have nevertheless made for it a niche in the history of the progress of human intellect; and modern science, less strict and classical but more fecund, has seized on the idea and held it as a thread to guide among the intricacies of a more profound and wide-reaching analysis than that which wove it first. Abandoning the former inadequate distinctions of *plane* and *solid* and *hypersolid*, it has imparted a wider generality to the whole theory of curves; those that were before excluded as *mechanical*, it now treats as *transcendant;* and for the present application, shews how, by the revolution of a cubic equation, the condition for trisection may be met.

But the elaboration and refinements of these methods of calculation, unfit them for practical use, as in the majority of cases where the result alone is wanted; and I have thought, therefore, that it might be of some interest to present a mechanical method for effecting the purpose with as much accuracy as is desirable or necessary in most instances. This is done in the present description of the accompanying figure (p. 245) of a New Protractor for Trisecting Angles. New, I believe it is; for it will hardly be found elsewhere; but it is to be observed that its device does not require much ingenuity; and its merit, if it should be allowed to have any, consists in its appropriateness and simplicity. An explanation of the principle on which its device reposes, will be at once the best introduction and commentary upon its mode of working and use.

Referring to the lines and letters in the figure which gives the projection of the instrument, if we have any angle ACD required to be trisected; and with any radius AC, be described the arc AED with its centre at C; and with the same radius but with

the centre at A, be drawn a semi-circle (which in the figure coincides with the outer circumference of the protractor) whose diameter passes through A and C and is thus coincident with one leg of the given angle; and the points A and D be joined by a straight line: then whenever of a radius prolonged from C the distance A′C′ intercepted between the straight line AD and the circumference of the semi-circle is equal to the original radius AC, the arc AE (cut off by a straight line joining A′ and C) is one-third of the original arc AD; or what is the same, the angle A′CA is one-third of the given angle ACD.



A New Protractor for Trisecting Angles.

These relations are very manifest; for, assuming the construction as given and supposing the triangles to be completed by joining the points AA′ and CC′ (which are in the figure left to be imagined), we have AA′C′ and ACE, two equal and similar isosceles triangles; and because isosceles, with the side A′C′ equal to AA′ or AC, that is, to the radius in question. Also ACE being an isosceles triangle, C′AE is likewise isosceles and similar, for both have AEC′ a common angle at their base. The angle EAC′ therefore is equal to the angle ECA. But the angle EAC′ (or EAD) at the circumference is subtended by the same arc ED which subtends the angle ECD at the centre; and is therefore one half of this last. The angle ACE (the equivalent of EAD) is then one half of ECD; and so is one-third of the given angle ACD, which is the sum of its double and itself, q. e. d.

In the device of the protractor, I have done no more than render permanent the essential parts of the construction. In point of fact, it is quite easy, with a little tact in manipulation, to dispense with apparatus at all more than a graduated scale and a pair of compasses, against whose point held at C, the scale revolves until the number of its divisions intercepted between the chord AD and the semi-circle previously described, equals the number assumed originally as radius. But as the management

of these separate pieces may be found cumbersome and inconvenient. I suppose the present combination to possess certain advantages. The body of the protractor, then, is a semicircle of metal or of ivory and of any diameter. A diameter of four inches, is about the most advantageous, for if it be much larger, it leads to the necessity of prolonging the line of the given angle—an operation not merely imposing additional trouble but introducing occasion for inaccuracy; and if it be much smaller, the possible error masked in the apparent coincidences becomes of course proportionally greater. There is no graduation on the protractor; only its centre is marked with A, for precaution and reference. At C, as nearly as possible in the intersection of the diameter and circumference, is centred the pin or journal on which the movable arm works; and the center should be marked here for the same motive as at A. The movable arm itself is a cylindrical steel wire, eccentric to its axis but parallel to the geometrical radius; and on it, slides, retained by two straps and hugging by a longitudinal faint spring inlaid beneath and not visible from above, the ivory scale A′EC′ of such width and so adjusted as that its fiducial edge shall coincide with any radius drawn from C and having the length of the original radius A′C′ marked with a fine perpendicular notch through and through. This notching instead of simply cutting on the surface, is to avoid parallax and to compensate for the obliquities of intersection, as well as to allow the point A′ to be pricked on the paper or board, not external to, but in the actual line of the radius from C. The proper horizontality of the scale necessary to maintain the coincidence of its fiducial edge with such a radial line, is assured by the constant contact of its lower face with the plane surface of the limb (or if necessary of the diameter, through its whole extent) of the protractor.

After this description of the parts of the instrument and their adjustment, the mode of its use is very apparent. It is only necessary from the vertex of the angle given on the paper or the board to lay off on each leg a distance equal to the radius of the protractor; to draw a line joining the points respectively terminating such distance; and to lay the protractor so that its centre coincides with the terminal point on the left of the vertex and its fiducial diameter with the angular leg, when the point C will of course be adjusted to the vertex of the angle. Then holding the protractor firm to its place with one hand, with the other move at once both the revolving arm and the sliding scale until the base of the triangle and the edge of the protractor are seen at the same time through the notches A′ and C′. A fine needle pressed down at A′ will then give the point through which after the protractor is removed, a straight line drawn to the vertex of the angle will lay off the trisection required.

Such trisection is not unfrequently desired in the geometrical drawings and designs in various branches of engineering; as for instance in carpentry, in church architecture and in fortification especially. For persons engaged in these branches, an instrument like the one I have described will very likely afford some interest.

ART. XXV.—*Notes on Upper California;* by JAMES D. DANA. From Observations made during the Cruise of the United States Exploring Expedition, under Capt. CHARLES WILKES, U. S. N.*

THE party with which the writer was associated on a tour from Fort Vancouver to San Francisco, was under the command of Lieut. G. F. Emmons, by order of Capt. Charles Wilkes. Our route lay between the Cascade Range and the sea.

On the 30th of September, 1841, we reached the Clammat (or Tlamath), a fine river just south of the parallel of 42°, and encamped on a narrow plain not far from its banks, near the meridian of 122¾° W. The lower elevations and the loftier hills around consisted of tertiary sandstone, dipping at an angle of 20°; while the summits of the principal heights were composed of basalt outcropping through the stratified rocks. The slopes were strewed with chalcedony and agates, that had fallen from the decomposing basalt, and the soil partook of the chocolate-brown color, loose texture, and fertility, usual where this rock prevails. Much of it was deeply cracked from drying during the long drought. The sandstone resembled the tertiary rock of Astoria, and was probably of the same age—the miocene. It was soft and friable, and of a grayish white color.

The view from a neighboring eminence was a pleasing one. An open prairie thinly covered with oaks, and bearing occasionally a grove of pines, lay spread out among grassy hills and other elevations bristled with evergreens. The Clammat seemed to flow along a narrow valley from the far east, and continued its course among the hills that broke up the country to the westward; and a streamlet with a border of shrubbery meandered over the plain towards the river. A rounded summit, exceeding one thousand feet in height, stood to the south-southeast, and shut from sight the snows of the Shasty Peak, a volcanic cone, twelve to fourteen thousand feet high, which had been in view from mountains just north of the Clammat.

* The Geology of the region here treated of is described with more systematic detail in the Exploring Expedition Geological Report of the author, which is just now printed excepting the Plates. It forms a volume of 760 pages in 4to, to be illustrated by 3 maps, besides 21 plates of fossils in folio.

October 1.—The morning was, as usual, cool. At dawn the thermometer was down to 32° F., while at noon of the preceding day it had stood at 90° F. in the shade. We ascended the Clammat two miles, and forded the stream in 2½ to 3 feet water. It was 80 to 100 yards wide, and much of the way ran in rapids. Passing to the northward of the rounded summit just alluded to, over a region of sandstone hills, affording a dry soil and scanty vegetation, we next traversed for five hours an undulating prairie, much of which was as dry as the hills, and, besides, black and desolate from the recent fires. The prairie in some parts abounded in pebbles of milky quartz, indicating by their characters the existence of talcose rocks in the vicinity. A generous rivulet six to eight yards wide was finally reached, and afterwards a still larger stream, with green banks, afforded a good place for encampment. The two unite and flow northwestward into the Clammat.

After travelling upon this prairie for about six miles, we came to a low outcropping ledge of sandstone, extending across the plain from east to west, and dipping fifteen degrees to the northward. Nearly six miles beyond, we passed a heap of volcanic rocks, consisting of masses of grayish and reddish porphyritic lava, one to ten cubic feet in size, lying together in a disorderly pile. The rock contained crystals of glassy feldspar thickly disseminated. As we continued on, these heaps of lava blocks became numerous; and the plain was thickly covered with rounded and conical hillocks of broken lava, twenty to two hundred feet high—averaging sixty feet. A few had table summits. Although generally covered with soil, the black rocks outcropped at top, and lay scattered over the surface. This soil was a red or brownish-red earth, arising from decomposition, and it appeared remarkable that it was scarcely at all mingled with the alluvium of the plain: on the contrary, the soil of the prairie had the color and characters due to a sandstone origin, proving that this *Hillock prairie* had been leveled under water after the volcanic rocks were thrown up. In the course of about five miles, these hillocks of lava became so crowded together that the plain almost disappeared between their coalescing declivities; and we observed beyond, that still nearer the mountains, the country gradually changed to a region of rough rounded hills, which, increasing in extent, rose into high ridges lying at the northern base of the Shasty Peak.

A hundred yards from our encampment, a spot in the plain was covered with incrustations of salt, and salt plants (a species of *Salsola*) were abundant.

October 2.—Continuing southward, we had to the west, within half a mile, high smooth-featured hills, evidently consisting of sandstone; and about the same distance to the eastward, the region of volcanic hillocks already described. In several places

the ground sounded hollow under the horses' hoofs. Till noon, the soil was dry and pebbly, and mostly of sandstone origin. About midday we passed another saline with Salsolas, lying about fifteen feet lower than the usual level of the plain. The western hills afterwards became more bold in their features, and the rocks stood out in black points over much of their surface. The foot of one of the ridges, where crossed, proved to consist of a dark green serpentine; and pebbles of the same rock, bleached externally from exposure, were abundant. The rock contained amianthus and green diallage, its characteristic minerals. Half a mile beyond, near our encampment, the rock was a beautiful syenitic granite, or syenite, containing large crystals of hornblende, some of them two inches long. The ridges to the westward rose to a height of 1500 or 1800 feet.

The smoky haze which had concealed the Shasty Peak during our journey across the prairie, still continued, and although within twenty miles of its base, we could barely discern as if in distant space far above us, faint traces of its snowy summit in a few dim lines and shades.

October 3.—On the morning of the 3d the Peak was visible until half an hour before sunrise, when a thin haze again veiled it from view. Following up the small stream on which we had pitched our tents the night before, we soon reached its head and struck into the forests of the mountains. The high syenitic ridge had continued to bound our view to the westward, and a very uneven hilly region lay to the eastward; some hills of lava were passed within fifty yards of the syenite. The plains left behind had been partly covered with pines and were highly fertile. The mountains before us were a mass of lofty ridges ranging from east to west and situated to the west of the Shasty Peak. They form a natural boundary across the country, dividing the Clammat region from the district of the Sacramento; and where passed by us, they occupied a breadth from north to south of about forty miles, though twice this distance by the zigzag course we followed.

Entering the mountainous region, we travelled for several miles over trachytic lava and trachyte, which lay in mounds and ridges, or in scattered blocks among the trees. The rock had a light gray or grayish blue color, a nearly compact texture, a rough surface of fracture, and contained slender crystals of hornblende. It afforded in some places a light-gray ashy soil, which, near a burnt tree, was occasionally of a pale reddish tint from the action of the heat. We had several views of the Shasty Peak through openings in the mountains, and passed within a few miles of the foot of a lofty cone lying near its western base. This cone had regular sloping sides, and truncate top, and was evidently an extinct crater, made of ejected cinders. It retained all the freshness and regularity of a recent formation.

The Peak is one of the lofty volcanos of the Cascade range. It had two summits as seen from the southwest, and between them there seemed to be a depressed plain; but no distinct crater could be made out in the distant view. Each summit had probably been a separate place of ejection; the smaller appeared as if it might bear the same relation to the larger, as Vesuvius to Somma. The sides were covered with loose fragments, without vegetation where in sight, and had the ashy color of the trachytic rocks passed on our route. The snow was in banks or patches about the more sheltered parts of the top, and not in an unbroken coat, as about St. Helens. The declivities were in general but little broken; but the southwestern face, from the summit down three or four thousand feet, was intersected by projecting ridges of rock that stood out in points and walls and cast long shadows over the slopes; these shadows indicating a height of at least some hundreds of feet. They were evidently walls or dikes of volcanic rock filling former fissures in the crater, and now projecting owing to the removal of the rock material that enclosed them.

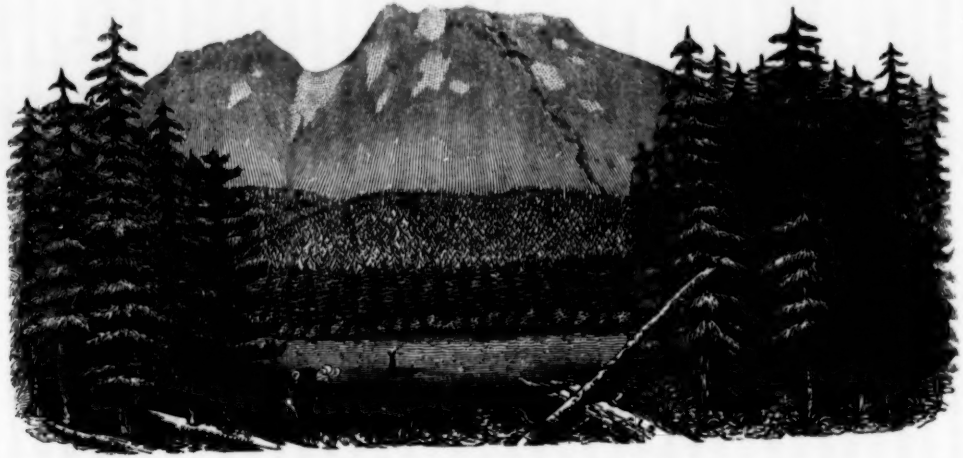
No time was allowed for closer exploration, as the party continued its course without stopping.

The only traces of existing fires in the vicinity of the Shasty volcano are found in a hot spring described to me by Mr. MacKay, as occurring to the east of the Peak, near a track sometimes taken by parties to California. It is said to issue from among the rocks, and my informant assured me that he had boiled eggs in its waters. The stream running from it had worn the rocks smooth and formed a small basin below, which was much frequented by the mountain sheep.

Obsidian or volcanic glass is said to occur in some parts of the Shasty region; but we met with none of it. The Shasty Indians use this material for their arrow-heads, which they work out with great skill and delicacy.

Within eight or nine miles of our preceding encampment a tributary of the Sacramento was flowing at our feet, and half an hour beyond, our camp was pitched on another of the streamlets flowing from the Shasty mountains and forming one of the beginnings of the large California river.

October 4.—The thermometer at 2 A. M. on the morning of the 4th, stood at 32½° F. We were off on our way through dense forests of evergreens, and soon left an undulating country by a descent into a gorge two hundred and fifty feet in depth. The rock thus far trachyte and evidently pertaining to the Shasty eruptions, soon changed to the talcose rock formation, and pebbles of quartz and talcose slate were abundant along the bed of a rivulet. Again we passed for a few miles to trachyte, and before finally leaving this rock, we came upon a small *Chalybeate*



The Shasty Peak—bearing by compass N E b N.

Spring, in the vicinity of Destruction river, the affluent of the Sacramento which the party thence followed on their way south.

Descending a few yards to a small plain on the border of the river, the spring was observed near by on our left. The water was oozing from among the rocks into a basin scarcely holding a gallon, and flowed down over a small marshy spot thickly covered with iron-rust. It was brisk and pungent with carbonic acid, and was called by the trappers *soda-water*. The taste was agreeably acidulous and chalybeate, without any thing saline or alkaline. Fifty yards beyond the spring, there was a shallow ditch a hundred yards long, containing about half a foot of water similarly chalybeate, but less brisk with carbonic acid. Our horses drank freely of it, and with good relish. The temperature of the spring was as cool as that of the mountain torrent near by.

The passage through the mountains occupied us from the 4th of October till the 10th. Destruction river was at first but a mere rivulet; it increased rapidly to a brawling torrent, and then to a large stream several feet in depth. It is a succession of cataracts through a great part of its course, affording scenery of the wildest character, as it dashes impetuously through its narrow defiles, over the rugged rocks. We seldom could travel even for a short distance upon its banks. Through our whole course, till we emerged upon the plains of the Sacramento, we were ascending and descending,—now up a rocky steep several hundred or perhaps a thousand feet high, and then to the bottom of the craggy valley. The view ahead varied but little: ridge beyond ridge appeared to interlock below along the river.

Soon after leaving the Chalybeate Spring, we were again on talcose rocks and syenite, and beyond soon passed to granite. From our encampment on the night of the 4th, a valley on the west opened to us a magnificent spectacle of needle peaks and lofty pinnacles of granite. This bold crested ridge was about three thousand feet high above the plain at its foot, and one massy peak overhung the valley. A few evergreen spires stood in the clefts of the ridge; otherwise it presented a bare surface of grayish-white rock. A whitish debris covered the slope at its base, and the valley was strewed with boulders of granite.

The granite of the region has a very light color and looked in the distance much like cliffs of chalk. It was generally albitic, containing white albite, either in place of feldspar, or associated with it. In some places the feldspar crystals disseminated through the albitic rock measured one and a half by two inches in their dimensions. The mica was usually in small black scales, but sometimes silvery: it was not abundant.

At one place the rock was a granular compound of albite and quartz. The granite passes gradually into syenite, first a few crystals of hornblende appearing in the rock, and then beyond, this mineral becoming a characteristic ingredient.

The syenite often contained albite. In some places, the crystals of hornblende in the white rock, were two or three inches long. One variety was a grayish rock thickly speckled with small square or rectangular spots of albite, the grayish base consisting of a mixture of albite and fine crystals of hornblende. This and many of the other varieties were beautiful rocks for architectural purposes. The syenite graduated into a variety consisting almost wholly of hornblende.

The talcose rock was either slaty or compact, and much of it had the characteristic soapy feel. An imperfect steatite or soapstone was met with, too hard and gritty for the ordinary purposes of this material. The compact variety has a siliceous or flinty appearance, though generally some dull greenish shade from the presence of a little talc or hornblende. It breaks with sharp angles and is usually much fissured.

October 5.—We continued our rugged way down the valley, up and down the hills that border it on the west, travelling over rocky declivities often covered with sharp broken stone and in many places barely accessible. The hills to the eastward were still higher and more abrupt, varying according to our estimate, from eight hundred to eighteen hundred feet. Destruction river dashed noisily along its stony bed, confined much of the way on both sides between hills several hundred feet high. We left the granite after a while for hornblende rock and the talcose rock formation, the last prevailing through the latter part of the day. Often the two kinds of rock were closely associated or intermingled as if parts of the same formation, the pearly talcose slate occurring in the same ledge with hornblende slate. The talcose varieties were often compact and broke into angular fragments. The schistose structure when apparent, and the principal fractures, were nearly vertical in dip. Occasionally the rock had the color of serpentine, and a variegated appearance like verd-antique marble; then again it was pale copper-blue or light green, in color. It passed also into a hypersthene rock, somewhat schistose, containing pearly plates of hypersthene. At two places we observed broad dikes of porphyritic basalt, with a corresponding change in the soil.

October 6.—Through the day, ascending and descending the mountains that enclose the valley of Destruction river. It was not unfrequent that a pack-horse, upon a steep ascent, fell over backward and rolled down hill with his load: yet there were no serious accidents. The horse tried his legs again with better success for his experience. At noon we climbed a steep ridge to a height of 800 feet, and then began an immediate descent to a still greater depth. The rock thus far (excepting some dikes of porphyritic basalt) had been talcose, and a dark blue-black argillite with a talcose lustre; the latter was thin fissile, and though

often contorted, the cleavage was generally vertical, or nearly so. But at this ridge we came upon a coarse sandstone and fine siliceous conglomerate, extremely hard and compact. It had a light color, and the rounded pebbles were mostly white, though at times black. Beyond, we found again porphyritic basalt. The hills for the last two hours of the day were more bare than usual, being covered usually with shrubbery and but few trees. We encamped on the upper prairie of the river, a fine grassy flat shaded by a few pines.

October 7.—The sickness of two of our number detained us at our encampment through the day. The rocks along the stream were a blue argillite and compact sandstone, which dipped to the northeast (compass course) about 60°. Some of it was a grayish green rock breaking into regular fragments, and slightly glistening with minute scales of mica. No fossils were observed. Across the stream, the sandstone and argillite formed a precipice of 70 feet; it was horizontally stratified, and very much fissured in various directions. The sandstone is an extremely hard compact rock, in which it is difficult to distinguish minute quartzose grains even with a lens.

The boulders along the stream consisted mostly of the hypersthene rock, of grayish, greenish and brownish colors, and pearly with hypersthene, along with masses of syenite and hornblende rock, some of hornblendic gneiss and granite, and others of puddingstone and basalt.

October 8.—Soon after leaving our encampment on our way down the stream, we found the sandstone passing into a conglomerate. We travelled over an undulating and hilly country, avoiding a mountain of 2000 feet which we left between us and the river, forded the stream three times in the course of the day, and finally encamped again near its banks, on a fine meadow, under a shade of oaks. The whole distance with small exceptions was very rocky. Along the bottom of the valley, the rocks stood up in ledges, ragged points and rude hillocks; and during freshets the river must present a scene of frightful grandeur. These rocks consisted of puddingstone alternating with slate and sandstone, and dipping from 30 to 60°, yet often vertical. At our second ford, the strata were inclined 65° to the northwest and west-northwest, (compass course,) and near by became vertical; they consisted of both shale and puddingstone. The latter was a very hard rock, made up of rounded siliceous pebbles, many like flint and various in their colors. The rock might make good millstones. The slates were fine grained, and neatly fissile, splitting into thin plates. Quartz veins and seams were numerous.

October 9.—Continued down the valley, over hills and ridges, mostly an arid country with little grass and only scattered pines and oaks. The stream was enclosed between bare rocks on

either side, which were extremely rugged and broken. Talcose rocks prevailed along the route; they were sometimes thin slaty, and often compact. The latter passed into a compact rock of a bluish-green or grayish-green color, giving a light greenish tint to the water, when forming the bed of the river. The river was still a rapid stream; it was about eighty yards wide, and averaged four feet in depth. The rocks stood up in jagged points, and the hill-sides were covered with angular fragments. One hill consisted of protogine, a granite-like rock composed of feldspar, quartz and dark olive-green talc, in rather coarse grains, and containing some spots of compact talcose rock. It was nearly white in color, and much disposed to crumble.

October 10.—After three hours' travelling, the last hour over an undulating region densely strewed with pebbles, among which few blades of grass found place, we reached the summit of a terraced slope sixty feet high, and looked over the wide plains of the Sacramento. This terrace was visible far southward; and also to the northward and eastward it formed a distinct border to the river flats. The distance to the river was estimated at about 1200 yards. After passing 700 yards there was a second descent of six feet, and 400 yards beyond another of eight feet: 100 feet from the last the river was running along beneath banks twelve feet high. We soon after found that the eight feet of the last terrace belonged properly to the river banks, twenty feet being their prevailing height. It was an example of a plain formed by the wearing action of the river floods below the usual height of the bottom land, and served as a caution against considering every terrace observed as proof of a distinct change of level. The soil of the lower prairie was rather pebbly.

We encamped on the banks of the river, and soon were visited by numbers of Indians. They had thick bushy hair, descending low on the forehead; in some it was parted along the ridge of the head, and hung down on the shoulders, while in others it was divided either side, and that of the top from the forehead to just back of the crown was collected together and tied with a string of deer-skin. A loop of the same kind, sometimes with a bead upon it, and about two inches long, was tied in the ear. The Indians were mostly quite naked. A few had a deer-skin, raw or dressed, thrown over one shoulder, or tied around the loins. Their faces were usually painted with black or brownish red paint; some with the forehead black, and a black triangle covering nearly all of each cheek, one angle being at the mouth; others had the ochre put on in zigzag lines over the forehead and cheeks, or in spots with zigzag margins. The women had the lower part of the face, below the line of the mouth, tattooed. The features were more regular than with the Chinooks of the Columbia river; the cheek bones but moderately prominent; the

nose but little enlarged and hardly flattened; the mouth large; the length of the face well-proportioned to the breadth. They were full of jest and merriment; and it was difficult to obtain any words of their language, as they would soon begin to laugh when questioned, and refuse to reply—thinking it, apparently, all a joke. They valued beads, tobacco, and knives, but refused blankets, and cared nothing for powder.

This camp was situated about 160 miles in a direct line from Sutter's, near latitude 40¾° N., or about 120 miles above the Bute.

October 11.—Soon after leaving camp, we ascended a terrace of twenty feet, and half a mile beyond reached the upper prairie, here reduced to a collection of hills, of nearly uniform height, and showing sides of stratified earth and gravel, rather firmly compacted. The streams and rills of the rainy season, had carried on the process of excavation and removal, until the former plain was only traceable in the uniform height of the hills. Large streams (dry when passed by us) had made valleys 300 feet in width, which were strewed with loose rounded stone. The surface of the region was nothing but gravel and coarse pebbles, and proved extremely hard travelling for the horses. After a while the hills became wider undulations, yet the character of the country was the same; the whole was arid, but bore some shrubbery and scattered oaks. This region fronts the bottom land of the Sacramento with slopes from 60 to 100 feet in height, and gradually rises in the course of a few miles back, to 150 or 200 feet. It is properly the upper terrace of the valley.

The pebbles were mostly siliceous, many of red jasper, intersected by veins of quartz, and others of milky quartz or fragments of the talcose rock formation. There were a few of porphyritic basalt and puddingstone. After fifteen miles over the pebbly hills, we descended to the lower flats, and encamped near the Sacramento, a noble stream 100 yards or more wide, flowing placidly along between thinly wooded banks. This lower plain proved to be fine soil, though dry from the summer's drought, and mostly burnt over. The stones of the prairies were generally varnished with a pyroligneous oil arising from the burning of the grass. This oil had a smoky and acrid taste.

October 12.—Just below the encampment, the upper prairie bordered the river with a perpendicular bluff of 100 feet. We ascended it, and for four miles travelled over its gravelly undulating surface, occasionally descending into its intersecting valleys. At one place we found one terrace of thirty-five feet—a second, 300 yards beyond, of twenty-five feet, and 200 yards beyond this lay the river, between its banks of twenty feet. The lower plain was mostly a light-colored loam of sandy appearance, in this, the dry season.

After two hours, we forded the Sacramento in three feet water, and encamped on the eastern prairie, at what is called the Bear Camp, near the parallel of 40° N. The prairie was in part gravelly, but probably produces abundantly in the wet season. In the course of the evening, five grisly bears were killed. Deer were running through the camp in every direction, and many herds of antelope were seen. Wolves at night kept up a perpetual howl, and one came and carried off from alongside of our tents the skin of a bear. Bear stewed, bear roasted, and dough fried in bear grease, composed our evening meal.

October 13.—Travelled south over the lower prairies east of the Sacramento, which are four or five miles wide on this side, and found the soil fertile, except when we approached the margin of the *upper* prairie, where the country proved to be pebbly like the same region on the opposite side of the river. This upper prairie stretched along at an even height, not far from sixty feet above the lower plain. Some few pebbly spots were passed on the lower prairie. The pebbles were partly siliceous, like those seen on the eastern prairie hills, and like them indicated that the talcose rock formation was still prevalent in the mountains. There were also numerous pebbles of cellular lava.

The alluvial soil was in some places of a black color, and deeply cracked by drying, the cracks opening three inches and two feet deep. This fine country like the Willammet plains was covered with oaks,—the trees averaging about twenty to an acre. The common species bears a long spindle-shaped acorn which was food for both bears and Indians, the latter making it into a black loaf by roasting and pounding.

October 14.—The day was passed in travelling south along the lower prairie—a region of good alluvial soil, often black and deeply cracked; it appeared probable that during the freshets the whole was under water. There were scattered oaks as usual except for two or three miles. The upper prairie appeared to be six or eight miles distant to the east. In the west the plains were without apparent limits; but according to Mr. Wharfield, they extend about eight miles beyond the river. This makes the bottom land of the river in this part (thirty-five miles north of the Bute) fifteen or sixteen miles wide. Large herds of antelope and elk ran before us as we rode over the plains, and deer were often startled and went bounding off among the distant oaks. Encamped on the banks of the Sacramento about thirty miles north of the Bute. Wolves yelling as usual through the night.

October 15.—Journeyed on the lower prairie to Beaver (or Bute) creek and encamped on its banks. The country was perfectly flat, and but thinly covered with grass, and some portions afforded but slender pasturage. In general the soil was good; a considerable portion was a little clayey, and had been baked hard by the sum-

mer's sun. But the rains of the winter season, as with similar soil in the Willammet, would probably develop great fertility.

October 16.—To the south of our encampment there stood in the flat prairie an isolated collection of summits, the highest of which was about 1800 feet. It looked like a detached mountain ridge, much broken into peaks, with long low slopes at either extremity of the range, melting very gradually (at an angle of 5°–8°) into the flat bottom land of the river. This is

Sacramento Bute, bearing southeast-by-east.

the *Sacramento Bute*, called also the *Three Butes*. It was found to be an extinct volcano. The lower slopes are cut off in most parts from the central mountainous portion by a flat valley, three to four hundred yards wide; and they face this valley, or broad highway, with a mural front of one to three hundred feet. In the figure, *na* is a profile view of the lower slope, the belt of the Bute, which in many parts is a mile wide; and at *a* is the precipice bounding the interior valley. There are several openings to the valley through the belt; we entered by one of them on the south, and after travelling seven miles emerged again on the east, and at this eastern entrance encamped near a small pool of standing water.

The form of the Bute is nearly circular, and its diameter is about eight miles; it stands like an island in a vast prairie of millpond smoothness. The inner valley is to a great extent at the same level with the plains without, and during freshets, had evidently been covered by water.

The central peaks are steep and rugged, rising into bold crests at top. The rock is porphyry, or trachytic porphyry. The latter where first seen looked like a coarse syenitic gneiss. The feldspar was in large translucent crystals, and through the base small crystals of hornblende were disseminated. The usual colors were gray, reddish or purplish, and white. Another variety was laminated, and the laminæ were thin and easily separable, at times looking like porcelain. Some specimens were formed of alternations of chalky and compact layers, and one block broken open consisted of delicate stripes of white, light sepia brown, and a bright purple color. This laminated rock contained mica in hexagonal scales.

The Bute was evidently a volcanic cone. It is probable that the centre, at some period in its history, subsided, leaving only the lower part of the slopes entire. As rocks and fragments from ejections are not found over the prairie around, it was extinct before the present river flats were formed; and the overflow of the river has since filled up and levelled off the surrounding country,

as well as a large part of the annular plain. A hill of trachytic blocks near the eastern entrance may have been one of the later points of eruption. As the cone is partly buried in the river detritus, we evidently see only a portion of its original elevation, and it may be but a very small portion.

Upon the lower slopes of the Bute sixty to one hundred feet above the plain, we found again siliceous pebbles like those of the upper prairie, and these pebbles were the only traces of the terrace that were distinguished. They consisted of jasper and quartz, and had evidently originated from the talcose rock formation. There were also some of basalt.

The prairie before reaching the Bute consisted of loose alluvial soil, of a dark color, much cracked; for some distance it broke through at every step, and it was much like travelling over crusted snow. The whole country, we were told, was flooded during the winter freshets, and the deer and antelope of the plains then take to the Bute hills.

October 17.—The flat prairie south appeared to be less productive than on the preceding day, the grass being in straggling tufts, or covering the surface with a light furze. For twenty miles we found no water, and finally reached a line of trees that had long before been pointed out to us as the shore growth of Feather river. After following down the stream about four miles we encamped near its mouth in a grove of oaks. The river was a slow stream about thirty yards wide, with alluvial banks twenty feet high. An antelope was shot during the day, and a fat cow in the evening. Elk, deer and antelope were seen in great numbers.

October 18.—Forded Feather river in three to four feet water. Six hours of hot travelling over a flat prairie brought us to Sutter's settlement on the Sacramento. The soil was less fertile than much that we had passed, and for the last two and a half miles the surface was dry and gravelly or sandy. Other portions however were more productive.

A portion of the party took the river for the bay of San Francisco. At the straits of Caquines, bluffs of soft sandstone alternating with some clayey layers, formed the shores. The sandstone was neatly stratified in layers from four feet to one inch thick, and had a dip of 50° to 70° to the west and southwest, in some places it was vertical; and within two hundred yards it changed to an inclination of 35° or 40°. The faults were numerous. Although no fossils were observed, other characters lead me to refer it to the same formation with the Astoria sandstone, which Mr. Conrad has shown from the fossils to pertain to the miocene period. On a small island near these straits, gypsum is found in thick seams.

This sandstone is easily worked, and some layers will make a good building material. The Sacramento Bute, though distant from the settlements, must become more valuable for its stone quarries, the material being both durable and of handsome appearance.

North of the Bay of San Francisco, just east of Sausilito, we again found talcose slate of various colors, and also hills of red and yellow jasper in layers. The layers averaged two inches in thickness, but varied from half an inch to four inches. The talcose slate at one place, approached steatite in character and contained actinolite and nodules of an impure serpentine. Some fragments appearing like fossils were found in these rocks, but they were afterwards lost.

The region of the Sacramento is remarkable for the great extent of its alluvial flats. Two hundred miles from its mouth they are twenty miles wide, and near Sutter's, we were informed that the width was fifty or sixty miles. In the season of our journey, there was no green grass to be seen, except immediately along the water; the whole surface was dry, and the grass remained as standing hay for the cattle. The rains had not yet begun. They are generally delayed till the latter part of November, when they set in for the winter and occur at frequent intervals until the middle of March. The country about Sutter's is then mostly under water, and the same is the fate, as we were told, of a large part of the bottom-land of the river.

The distinct outline of the terrace between the upper and lower prairie is another marked feature of the region. This terrace is mostly about sixty feet high; but the plain above gradually rises to 150 or 200 feet. Its pebbly features were retained both east and west of the river, and also in the mere traces of it on the Sacramento Bute. This volcano, therefore, since it became extinct, has been washed by waters sixty feet or more above its present base.

The prevalence of talcose rocks over the route travelled is a striking fact. They abounded in the Shasty mountains, along the head-waters of the Sacramento in that region; and the pebbles of the upper prairie indicated their continuation far south. Moreover, we again met with them adjoining the Bay of San Francisco.

We had found the same rocks on the route farther north, south of the Umpqua river, and in the Umpqua mountains, an east and west range, just south of latitude 43°; and in some places they abounded in quartz veins. Their peculiar features in the Umpqua region, and also in the Shasty mountains about the Sacramento waters, as well as in pebbles farther south, led to the following statement in my Report, written soon after leaving the

country: "The talcose and allied rocks of the Umpqua and Shasty districts resemble in many parts the gold-bearing rocks of other regions; but the gold, if any there be, remains to be discovered."* The term Shasty district, here used, did not include the region of the Shasty Indians north of the mountains, (to which it is now properly restricted,) where the rocks were not found, but the Sacramento district where entered upon among the Shasty mountains: and although I was not warranted in giving the specific statement a wider scope, from finding only pebbles farther south, my opinion actually embraced the whole range of country. The same opinion would have been arrived at by any geologist at all acquainted with the modes of occurrence of gold. It is also quite probable, from indications observed by the writer, that gold may be found in many parts of the range of country between the Umpqua and Sacramento. The fact that this metal is often associated with talcose rocks was first stated as a general principle by Prof. Amos Eaton.† It is also well known that gold occurs in clay slate, mica and chloritic slate, as well as talcose slate, and but rarely in granite.

The writer was not over the region of the Sacramento mines, the route of the party being on the alluvial flats not far from the river. Moreover, the journey was necessarily as rapid as could be accomplished, since our time was limited, and the limits fixed were unavoidably exceeded. Besides, the Expedition, which had already been at sea longer than the time appointed on leaving the country, was upon the point of starting from San Francisco on its return. Less than four weeks were spent in travelling from latitude 42° south, a distance of 400 miles by our route, which is obviously a small allowance of time for developing the mineral resources of so large a country. It was but a hasty coup-d'œil, to be afterwards filled up in its details by others.

Appendix.—As there is much misapprehension among those interested in the gold of the west, respecting its modes of occurrence, a few words are added upon this subject. Many think to find the sands glittering with gold dust, and others in exploring the mountains hope to lay open rich massy veins of the precious metal, like those of ordinary ores.

The slate rocks alluded to—(compact, slightly glistening, slaty rocks, of various dark colors, the talcose more or less greasy in look or feel, and often greenish, and the chloritic mostly of a darker olive-green color)—contain often veins or beds of quartz, and in this quartz, (and often the rock immediately adjoining,) the gold is found;—not forming continuous lines of metal, but

* This sentence has been misquoted in the papers.
† See this Journal, vol. xviii, p. 50.

disseminated in grains, scales, delicate leaves or thin plates, irregular strings, and sometimes in rude lumps. The quartz being an extremely hard mineral, is quarried out with much labor. A large part of it may not show a grain of gold to the naked eye, and still by pounding, washing, and amalgamation, a considerable quantity may be obtained. Masses of quartz at the Moss mine, Virginia, examined during a visit of Prof. Silliman, yielded five to eight dollars of gold to the bushel of rock; yet no gold was previously detected, although examined by a magnifier.* In better parts of the vein, grains or strings of the metal may be at times visible, and very rarely a lump of a few ounces, or perhaps pounds, is encountered. The largest mass of gold from the Russian mines was found in 1842, in Taschku Targanka; it weighed nearly 100 troy pounds.

The quartz is generally cellular, and sometimes tabular in structure. Iron pyrites is often present; and this mineral may contain gold in extremely delicate leaves. Galena or lead ore, and several other minerals, may also occur in the quartz. Magnetic iron is frequently found in the same region, and occurs as iron-sand in the soil; it is abundant in some of the Russian gold regions.

In the search for veins of gold, the most that can be hoped for, is the discovery of *quartz* in large veins or beds, which by dint of hard quarrying, the working of heavy stamping mills, and careful amalgamation will yield its produce, large or small as the case may be.

Alluvial washings, the world over, have been the principal sources of the precious metal. Among the Russian mines (which in 1846 yielded over $16,000,000) the rock is mined only at Ekaterinburg. The sand or gravel of a gold district, as that of California, is the rock ready pulverized by natural causes (wear from abrasion and decomposition); and it is thus made ready for the farther operations of the miner. The streams of water washing over this soil, still farther aid in the preparation, by collecting the gold into the bottoms of valleys and carrying off the light gravel and sand (these being seven times lighter than the gold), thus leaving the grains of metal along the beds of the streams and the bottoms of ravines.

Auriferous sands or gravel seldom contain the gold in grains that are visible without a farther careful washing by the miner; and often little then becomes apparent, until mercury is added and the process of amalgamation carried through.

The region covered by the debris of the California mountains is as wide as the vast prairies of its long-reaching rivers, and the slopes that rise into the ranges on either side. The gravel of

* This Journal, xxxii, 105, 106—1837.

these slopes and the stratified earth and gravel of the plains may therefore contain gold. But the parts more nearly in the vicinity of the particular gold-bearing rocks, naturally prove most productive; moreover, different layers in the soil, where they are a result of successive distribution, may differ widely in their yield. Again, as above stated, the gold will be collected most largely where the streams running through the earth or gravel have performed to some extent the washing process, the gold settling while the gravel is removed.

On the east, stands the Sierra Nevada, covered largely with snows, a perpetual source of water for streams. Consequently, the Sacramento receives from this side numerous tributaries, and into these tributaries a large number of rivulets flow along the ravines, and into the rivulets numberless rills from the hill sides. The last mentioned, from their steepness, carry the earth and whatever it contains into the ravines; the rivulets, also steep, leave along their bottoms part of the gold, but carry on another large part and much earth; while the large tributaries transport principally gravel and earth, leaving the gold to settle most abundantly towards their upper parts, though distributing the finer grains along their whole course. The American Fork, (emptying near Sutter's, about ninety miles from the sea,) Feather river with its many affluents (entering twenty miles further north), and other streams, from their sources in the mountains, have long been engaged in this washing process. Every winter's rains carry forward the process anew, on a scale of great magnitude, and will hereafter replace to some extent, what may be carried off in the other months of the year.

The Sacramento receives few tributaries from the west; for the coast mountains are not over 5000 feet in height, and the little moisture they condense in summer flows down the western slopes of the ridges. There are however some dry beds coursing through the plains that are generally filled in the rainy season.

The valley of the San Joaquin is a repetition, in nearly every feature, of the Sacramento. The two properly constitute one single north and south valley, 400 miles long, enclosed between the Sierra Nevada and the Coast Range.

The occurrence of alluvial gold commonly in flattened grains arises directly from the forms it has in the rocks, and partly from the wear and tear to which the whole is subjected. The abrading and battering action of the moving waters and gravel, besides setting loose the disseminated particles of gold, tends to reduce the leaves or laminæ to scales, breaks up the strings of metal to fragments, and wears off the rough exterior of the larger lumps.

Art. XXVI.—*Some remarks on the Navicula Spencerii, and on a still more difficult test object;* by J. W. Bailey.

I have learned from several quarters, that the notice of the new test object to which I gave the name Navicula Spencerii contained in Quekett's Practical Treatise on the Microscope recently published, has given rise to most erroneous impressions which justice to all concerned requires me to correct as far as is in my power. The work alluded to has not yet reached me, but I am indebted to a friend for the 8th and 9th plates, and the following extract referring to the test in question.

Navicula Spencerii.—Early in the present year, Mr. Matthew Marshall received some specimens of this species from Professor Bailey, of West Point, New York, who stated that an object-glass, constructed by a young artist of the name of Spencer, living in the back woods, had shown three sets of lines on it, when other glasses of equal power, made by the first English opticans, had entirely failed to define them. Mr. Marshall was supplied with the identical specimens on which Mr. Spencer's object-glass had been tried; these have since been carefully examined by Mr. Marshall and Mr. Warren De La Rue, and the nature of the markings clearly made out. Mr. De La Rue, has obligingly furnished the author with Plate IX, in which he has faithfully delineated a specimen of N. Spencerii, as viewed under a power of 800 diameters, and a portion of the same magnified 1,900 diameters, from which it will be plainly seen that the lines discovered by Mr. Spencer are in reality dots, and arranged so as to exhibit both transverse, longitudinal, and even oblique striæ, when viewed by an object-glass not capable of separating the dots one from the other. Mr. De La Rue has further made out that the dots are not projections from the surface, but are either perforations or depressions. The shape of the shell is not unlike that of a small kind of N. Hippocampus, which the markings also very much resemble.—p. 440.

The above notice is accompanied by a plate drawn by Mr. W. De La Rue representing the object as seen by him, magnified 800 diameters, and a figure of a portion of the same magnified 1900 diameters is also given to show the supposed perforations.

I believe the impressions which have been generally received by American microscopists, on the perusal of the above, are that it indirectly charges me 1st with underrating the English microscopes; 2d with over-rating both the merits of our own artist Spencer, and the difficulties of the N. Spencerii as a test object, and lastly, that the structure, or markings upon it, have been wholly mistaken both by Spencer and myself in consequence of our working with glasses "not capable" of properly resolving the object in question, and hence greatly inferior to those made in London. A few remarks upon each of these points will I trust suffice to correct these errors. To the excellence of the lenses made by Ross and Powell of London, I have always given most willing testimony, and in the only allusion which I have

ever made to them in print, I mentioned their superiority to any European glasses which I had seen, and I only claimed for Spencer that, judging from memory alone, his lenses showed me all that I had previously been able to see on the Navicula Hippocampus by the best English achromatic combinations. I made this statement at the very time when I knew that some of the best English microscopes in the country had failed in the hands of their owners, to resolve the N. Spencerii which Spencer has mastered; and I did not claim superiority for Spencer's lenses, as I fully believed that these British microscopes would also easily resolve the lines in question, if the peculiar management of light which they require was once hit upon. The correctness of this belief was shown by the first trials which I made with two London microscopes, one made by Ross and the other by Powell, and which was brought to West Point by their owners for the express purpose of trying them upon the N. Spencerii, an object which had hitherto baffled their endeavors to resolve it. It was prior to these trials that the letter sent to London "early in the year" was written, in which I stated that the English instruments in the country had failed to resolve the new test, and I feel very confident that in making this statement, I mentioned that up to that time I had not tried the English lenses on this object myself, and also stated the belief I always entertained, that they would resolve it by the aid of proper illumination.

It was certainly not so late in the year as the publication of Mr. Quekett's volume, when I informed the London artists through Mr. Marshall, that by aid of their instruments I had satisfactorily resolved both the longitudinal and transverse lines upon the object, on the first occasion when I had an opportunity of trying their lenses upon it. As I feel sure that the leading London artists will acquit me of all intention to underrate them, I will pass from this subject to the easy task of showing that I had not overrated Spencer's merits, nor the difficulty of the test object which bears his name and which he first resolved. Upon these points I will cite from original documents. Let us see whether the Londoners did not find *their* best instruments apparently incapable of mastering the object which our American back-woodsman had so successfully managed. The first letter which I received from London, informing me of the reception of mounted specimens of the N. Spencerii which I sent over to my friends in London, is dated May 20, 1848, and contains the following remark in which I have italicised the acknowledgments so frankly and honorably made.

"The evening I received your package there happened to be a small gathering of our microscopic friends. Your slide with the Navicula Spencerii underwent a long examination. *We how-*

ever could make nothing of it. * * * We had some of the finest glasses of Smith, Ross and Powell in our examination, and I am bound to state that at present the result is most unsatisfactory." A postscript to the same letter says, "Since the above was written, I have made several efforts to get at the markings on the N. Spencerii, but without success." A subsequent letter dated June 2d, 1848, says, "Still however, I can make nothing of your N. Spencerii, although I have employed one of Powell's best glasses with the power of at least 1100."

Knowing by my own experience that the difficulty which my London friends met with, was due to their not employing the much greater obliquity of light which this object requires than any other test previously known, I again wrote to London and sent particular directions concerning the mode of illumination used by Spencer and myself, at the same time expressing my belief that, (as was really the case,) before my letter could reach London the difficulty would be overcome. A letter received by me about the time, from Manchester, England, dated July 27, 1848, is as frank in its acknowledgment of the difficulty of resolving the N. Spencerii, as those from London above alluded to. It says, "You have indeed fixed us all now; D——, and myself have given the thing up in despair, and must confess ourselves thoroughly beaten by your Yankee back-woodsman."

The next letter from London announced, as I expected it would, the success of the London microscopists in resolving the test. It is dated July 28, 1848, and says, "I have had an opportunity of submitting your specimens to a very careful examination by the best glasses of Ross, Powell and Smith, our three best makers, and by oblique light we are enabled to resolve them most unmistakeably. But all our efforts to detect the markings by direct light proved fruitless."

From what precedes it appears that from the 2d of May to some time in July, the Navicula Spencerii remained in London and not a line, much less dots or perforations, could be seen upon it, although Spencer had resolved two sets of lines upon it by means of his lenses, mounted as he informs me in a *hand tube* and without the aid of achromatic condensors, adjusting screws or even a stage to support the glass slide, a feat, by the way, of the practicability of which I have convinced myself, but which is unparalleled in the history of optics.

It would be unjust to our English friends, if I did not now proceed to show what they developed upon the test in their subsequent trials. And it will presently be shown that Spencer has at least kept pace with them without any previous knowledge of their progress. A letter from London, dated August 18, 1848, says, "the N. Spencerii is certainly the most trying test I have yet met with. * * * I have resolved the cross lines upon it *mounted in*

balsam, without any particular management of light beyond what is attainable by the ordinary reflection. By the aid of Ross's $\frac{1}{13}$th we have unmistakeably brought out these markings on an object mounted dry, and by direct light through the achromatic condensor, and moreover resolved these lines into dots or granulations. I am prepared to say that should you be able to effect this, it will at once stamp Spencer as one of the first makers either in the old or new world. I ought however to observe here, that I think that ere long I shall be enabled to report the resolution of these markings by direct light even in the object mounted in balsam, having pretty nearly accomplished it in the last trial with a friend."

As Spencer long ago demonstrated the existence of both the longitudinal and transverse lines, it followed of course that if both sets could be seen at once, the surface would appear broken into little squares or granulations, precisely as in the much larger and easier test the N. Hippocampus. The resolution of these tests mounted *dry* is so much easier than when in balsam, that objects thus mounted are of little value in testing the powers of lenses, although they may answer well when the end is to make out the real structure of the object itself.

I proceed now to notice a discrepancy between Mr. De la Rue's measurements and my own, and to remark upon the existence of the depressions or perforations which he claims to have seen. I have carefully and repeatedly measured by means of Chevalier's camera lucida eye-piece, the distance between the transverse lines or rows of prominences on the adult Navicula Hippocampus, and have invariably found it to be about $\frac{1}{4000}$th of an English inch, and both by estimation and the most careful measurement I could make on an object so minute, the corresponding lines on the Navicula Spencerii are, as I stated in this Journal, at least three to five times closer, or from $\frac{1}{12000}$ to $\frac{1}{8000}$ of an inch apart instead of $\frac{1}{4000}$ to $\frac{1}{2000}$ as stated by Mr. De la Rue. To decide whether the appearance of lines on the N. Spencerii is due to the allinement of depressions or perforations, or to rows of elevations, or finally to two or more sets of grooves which by their crossing break its surface into granulations, is not an easy task if we confine our attention to so small an object as the N. Spencerii, but there can be no doubt that a perfectly analogous structure exists in all the Naviculaceæ (connected perhaps with their mysterious organs of locomotion), and the real nature of this structure can best be made out by studying the forms which are most coarsely marked, such as some of the species of Rhaphoneis, Sceptroneis, Cocconeis, Stauroneis and the large species of the genus Navicula, such as the N. Baltica and N. Hippocampus. If attention is paid to the direction of the shadows, and the deceptions due to *refracted light* are avoided, I believe that little doubt will be left

upon any mind, that rows of prominences, variously arranged, produce all the appearances of curved or rectilinear striæ seen on these objects, and nothing which I have yet seen on the Navicula Spencerii is at variance with the view.

If the lines seen on this species or upon the N. Hippocampus are due to rows of pits or perforations, I cannot see why they should not appear equally distinct and strongly marked whether viewed in the longitudinal or transverse directions, a fact which is easily explained by referring the appearances to two sets of grooves differing in depth, forming rows of prominences by their crossing each other. Mr. Spencer agrees with me in believing that all the lines on the Naviculaceæ are due to elevations or prominences, and these he states differ very much in form as well as distribution, in different species. I believe these prominences will be found on every species of the Naviculaceæ no matter how small, and that any species on which they cannot be made out will be a reproach to the microscope of the age.

I now proceed to give a few extracts from letters received by me from Mr. Spencer, referring to his first examinations of the N. Spencerii and his subsequent efforts. They appear to me to be of much interest, as illustrating his determination to reach the very first order of excellence, and an unwillingness to rest satisfied with what might justly have been considered splendid success. In his letter to me, dated Dec. 28, 1847, he informs me of his first reception of the N. Spencerii which I had sent to him, telling him that he *must* resolve at least two sets of lines upon it, although I could do nothing with it with my Chevalier lenses. He says, "I find the Navicula is striated, as you suppose, longitudinally and transversely. It required all the means and appliances I could command to resolve it. *But I hope the powers I am now making will tell a different story.*" In several subsequent letters he remarks on this test as being *too easy*, although the most difficult one known; and in a letter, dated August 23, 1848, he says, "I hope we shall soon be able to find a much more difficult object." In a letter, dated Nov. 4, 1848, he remarks on the ease with which the lines could be resolved on the objects mounted dry, and adds, "you have done more than I expected your objective would enable you to do, in resolving both systems of lines at once. *My late lenses will do this readily on all the specimens I have tried.* With a $\frac{1}{16}$ nearly completed, I observe the cross lines by central light by my hand tube, I trust to be able ere long to make out both systems by the same illumination." Finally, under date of Nov. 20, 1848, he announces the discovery of the long desired test object, which should exceed the N. Spencerii in difficulty. He says, "you will remember my calling your attention to a small shell among the infusoria from guano, and that an examination of the species re-

sulted in failure. I have finally mastered it. The same or a similar form occurs among the infusoria from Greenport, Long Island, which you sent me. The shells are beautifully cross lined, *much finer than in the N. Spencerii.* You will find this object worthy to head the list of tests."

The form alluded to is a species of Grammatophora, possibly referable as a *variety* to *G. oceanica*, Ehr., but which I propose to name *G. subtilissima*, on account of its exceedingly minute striæ. It is abundant on our coast, and its markings are so minute that with a glass which readily resolves the Navicula Spencerii mounted in balsam, I cannot detect a trace of lines upon this, and can only satisfy myself of their existence on the specimens mounted dry.

A fuller account of the new test will doubtless soon be furnished by Spencer himself. In the meantime the above hasty notice of it is given, to complete my proof that I have not overrated the powers of our native artist.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On some New Relations of the Diamagnetic Force;* by Prof. Plücker, (Proc. Brit. Assoc. for 1848., Athen., No. 1086.)—Mr. Plücker gave a short account of experiments belonging to a new magnetic action. A crystal with one optical axis being brought between the two poles of a magnet, there will be a repulsive force, going out from each of the poles, and acting upon the optical axis. According to this action, the crystal, if suspended, will take such a position that its optical axis is placed within the equatorial plane. When the crystal has two optical axes, there will be the same action on both; according to which, the line bisecting the acute angle formed by the axis will turn into the equatorial plane. When the crystal is suspended in such a way that it may move freely round any line whatever of the plane, containing both axes, this plane will take the equatorial position. Thus a crystal being neither transparent nor showing any trace of its crystalline structure, we may by means of a magnet find the optical axes. At the same time we get a new proof of the connexion between light and magnetism. When light is passing through a crystal, there are in general two directions, where it is effected in quite a distinct way,—these same directions are acted upon by a magnet.

Prof. Faraday contrived to convert two raw potatoes into representatives of the poles of an electro-magnet, and by a slice of another, with a quill stuck through it, represented the magnetic or diamagnetic crystal with its optic axes—and thus contrived to convey a distinct idea of the results of Prof. Plücker's discoveries of the relations of the op-

tical axes of magnetic and diamagnetic crystals, and the changes of distance to the nature and laws of the attractions and repulsions exhibited under the several circumstances detailed.—Sir W. S. Harris considered that the laws of magnetic forces in relation to the action of magnets on each other, or a magnet on a mass of common iron, were liable to vary, from the changes which arose in the amount of inductive action of which the attracting bodies were susceptible. He had shown, in a paper in the *Edinburgh and London Philosophical Transactions*, that in electricity and magnetism the amount of inductive disturbance was limited,—so that after a certain time, under given conditions, the disturbance became the greatest possible, and then the law of the force changed; and hence arose all the irregularities which had embarrassed early inquirers into this subject. In fact, the force between a magnet and a simple mass of iron varied in a simple inverse ratio with the force induced in the iron and with the disturbance conjointly. If either of them became constant, the whole force varied with the other. If, therefore, it should happen that as the disturbance in the iron approached a limit the changes were not uniform, then we obtained irregular results. So long, however, as the induced force went on uniformly, we had the total or absolute force in the inverse ratio of the squares of the distances. In the case of two magnets magnetized, or nearly so, the force of attraction between them varied in the inverse ratio of the simple disturbance, because the amount of the induced force had been reached. On this principle it was found that in the repulsive force between two magnets, the repulsive action at certain distances became changed into attraction; and it is not an uncommon circumstance to find two magnets attract at one distance and repel at another. These results he thought might be applied in explanation of some of the phenomena now under consideration. The force of magnetic action might vary, whilst the diamagnetic force after all may have been constant.

Dr. Lloyd inquired if Plücker had tried whether crystals with positive axes exhibited any difference in the laws of diamagnetic action from those which had negative axes?—Prof. Faraday replied, that Prof. Plücker had minutely investigated this point, and found no diversity of law corresponding to this difference in optical structure. Sir D. Brewster inquired whether Prof. Plücker had investigated the influence which changes of temperature produced in the diamagnetic action of crystals? Some of these changes, he conceived, were of such a nature as to afford an admirable test whether the same circumstances in the corpuscular constitution of the crystal on which their optical characters depended, were those which gave rise to their diamagnetic relations or not. For example, in some of the biaxal crystals, as sulphate of lime, when heated, the axes approached, and at length coincided,—the crystal becoming monaxal; and by continuing the heating, they again separated in a plane at right angles to the one in which they before lay. Such a series of changes, he conceived, if examined in relation to the diamagnetic forces, might afford a test whether the curious properties discovered by Prof. Plücker had their origin in the chemical constitution of the bodies, or in that corpuscular structure from which their optical properties originated. Prof. Plücker replied, that he had not

tried the class of experiments pointed out by Sir D. Brewster; but he admitted their importance, and expressed a determination to pursue the inquiry.—Prof. Grove inquired whether the experiments were tried with the crystals placed in vacuo?—Prof. Plücker replied no; but in every case they were suspended either in air or in water.—Prof. Grove pointed out the necessity of caution in that case, as it was well known that differences between the diamagnetic actions of suspended bodies and of the surrounding medium would sometimes mask and even reverse the action.—Prof. Faraday pointed out the precautions which had been taken to avoid this source of error.

2. *On the Action of the Red, Orange and Yellow Rays upon Iodized and Bromo-iodized Silver Plates, after they have been affected by Daylight, and other Phenomena of Photography;* by M. CLAUDET, (Proc. Brit. Assoc., Athen., No. 1086.)—It was shown by MM. E. Becquerel and Gaudin, that a photographic image on a Daguerrotype plate might be developed by the action of the light which permeates yellow and red glasses, without the aid of mercurial vapor. M. Claudet has been continuing his researches on this point, and he confirms those results in a very striking manner. Numerous specimens were exhibited, in which it was shown that the powers of the so-called *continuating rays* in developing the image were not much inferior to the mercurial vapor —presenting a positive image like it, but differing from it in the tint by which it is suffused. M. Claudet suspects that this result is owing to the decomposition of the iodid and bromo-iodid of silver by the least refrangible rays—and that the whites are represented by finely-divided silver in the place of mercury. The rate of action when the chemical agency permeates these colored media is infinitely reduced for these preparations; but still it is evident that some of the photographic principle permeates them—and also, that these rays which correspond in color with those media have a peculiar scale of action of their own.

3. *On the Influence of Light in preventing Chemical Action;* by Mr. R. HUNT, (Proc. Brit. Assoc., Athen., No. 1086.)—Bearing on the same subject as that brought forward by M. Claudet, although differing inasmuch as one set of experiments were made upon iodized silver plates and the other upon iodized photographic paper, this subject was taken by the Section before any discussion was allowed on the preceding communication. Mr. Hunt having called attention to several experiments in which certain luminous rays had been found to protect photographic agents from chemical change—particularly in the researches of Sir John Herschel,—proceeded to describe his own experimental investigation of this subject. Taking a piece of highly sensitive photographic paper, which would blacken in a few seconds by the light of an argand gas burner, he threw upon it a condensed spectrum which had been previously analyzed by a peculiar yellow medium—and then, by means of a mirror, reflected the strong light of the sun upon the paper. It was, therefore, under the influence of the unaltered reflected radiations—and also of the spectrum, from which the chemical agency had been as nearly as possible separated. The result was, that the paper was blackened over every part except that portion upon which the strong line of spectral light fell, which was protected

from change *and preserved as a white band* in the midst of the darkened paper. This experiment was thought by the author strongly confirmatory of the view which he had taken, that of actinism, or the chemical principle, and light, so far from being identical, are opposed in action to each other.

4. *An Examination of Berkeley's Theory of Vision;* by Sir D. Brewster, (Proc. Brit. Assoc., Athen., No. 1087.)—Sir D. Brewster's attention was turned to this subject by having been called on to give a course of lectures on the Philosophy of the Senses. He was thus led most minutely to examine the well-known theory of vision by Bishop Berkeley, and made himself minutely acquainted with its details. He found, as he conceived, the fundamental principle, on which the entire theory reposed, defective. Berkeley's first proposition, which contained that principle, was that direct distance from the eye had no linear representative in the image on the retina, and therefore that distance from the eye could not be a direct object of vision: now this first proposition Sir D. Brewster conceived to be false in fact, and therefore the entire theory which was founded on it must be abandoned. That there was a direct linear representative on the retina, even as seen by a single eye, he showed by a diagram to be the result of the rays entering the pupil; and let the pupil be of what size it may, unless reduced to an actual point, which it never can be, it must allow the rays to form an impression of the entire length of a line stretching away directly from the eye, and therefore objects do not appear all at the same distance from the eye, as would follow from the Bishop's theory. But further, Dr. Berkeley founded his entire theory on an assumed fact, which, if true at all, could be so only when one eye was used alone. Man is not an animal with but one eye. An infant obtains his first glances of the external world by opening on it both eyes; and from whatever sources its lessons are derived, both eyes must be admitted to be equally efficient in the knowledge conveyed. In determining this question, he did not consider it essential to decide how single vision with two eyes was effected. It might be from the images falling on corresponding points of the retina,—an opinion now exploded; or from the decussation of the filaments of the optic nerve,—an opinion also exploded; or it might be the necessary result of the line of visible direction—as it certainly was. But wheresoever it originated, it was a fact which must be admitted. They had therefore to determine at what distance, and in what direction, a body would be seen by two eyes when seen single; a determination greatly facilitated by that beautiful instrument the stereoscope of his friend Professor Wheatstone. —Sir David then, by reference to diagrams, explained how this determination was aided by the use of both eyes; and in confirmation of his views appealed to facts recorded by naturalists, to prove that the young of animals saw distances correctly almost at the instant of their birth. The duckling ran to the water almost as soon as it broke the shell. The young Boa constrictor would involve and bite an object presented to it; and in like manner no person ever saw a child use such motions as proved it to perceive objects at its eye, to grasp at the sun or moon or other inaccessible object, but quite the contrary. He also con-

tended that the recorded cases of persons restored to sight by being couched for cataract, or having a pupil formed, led to a similar conclusion;—all of whom saw objects at a distance from the eye, and none supposed those objects to be upon the eye or within it.

Dr. WHEWELL, after expressing his strong sense of the general value and ingenuity of Sir D. Brewster's views, and his diligence of research, begged most respectfully to differ from him entirely in his conclusions. All the facts adduced by him were as well known to Berkeley, and to those who adopted and carried forward his views, as they were to Sir D. Brewster; and he could scarcely suppose that conclusions so firmly based upon facts, and harmonizing so completely with all that was known, would be overturned in a moment by a few well-turned sentences or ingenious popular deductions. As to those animals who were under the dominion of instinct, the question how they at first were aided by their senses, since it was most intricate, he conceived we could not hope to dispose of in this summary manner; and many doubted whether it was not so mysterious in its operations as to leave the question of its final solution at any future period most doubtful. But as to man, he had little doubt that the most convincing proofs could be adduced that he required experience to guide him in the uses to which, at least in mature life, he applied his senses; although he admitted that in infancy something resembling the instinct of other animals was to be observed. But if Sir D. Brewster had persuaded himself that infants, or even persons restored to sight at a mature age, could see the distances and directions of objects directly without any aid from experience, all he could assure him was, that there were many others fully capable of forming a sound judgment who after the most patient and attentive consideration of facts had arrived at a very different conclusion.—Mr. ESTIN, surgeon and oculist of Bristol, must beg to confirm the views enforced by Dr. Whewell. He gave several instances of persons whom he had restored to sight from total blindness, who previous to experience could form no idea whatever of the distances or directions or shapes of bodies; and in one instance the patient for a length of time was in the habit of shutting the eyes entirely and feeling the objects, in order to get rid of the confusion which this circumstance gave rise to. But as her experience grew more perfect, she saw with increasing correctness and pleasure, until at length her sight became perfect.

5. *On the Peculiar Cooling Effects of Hydrogen and its Compounds in Cases of Voltaic Ignition;* by W. R. GROVE, Esq., (Proc. Brit. Assoc., Athen., No. 1086.)—This communication was illustrated by an experiment, in which it was shown that a platinum wire, rendered incandescent by a voltaic current, was cooled far below the point of incandescence when immersed in an atmosphere of hydrogen gas. This remarkable cooling property of hydrogen, of course, became the subject of experimental examination in comparison with other gaseous media. By a very ingenious arrangement, tubes containing coils of platinum wire were filled with hydrogen and other gases, and then being plunged into water in which delicate thermometers were placed, the wires were traversed by the same current from the battery, and it was found that the water was always more heated in a given time by the

wire in the tubes of oxygen, nitrogen, carbonic acid, carburetted hydrogen, &c., than by that in the tube containing pure hydrogen. It became necessary now to ascertain the cause of this peculiar phenomenon of hydrogen. It was found not be due to specific heat, nor to the conducting powers of the gases. Convection did not explain the fact; considerable difficulty was found upon examination if it was attempted to refer it to the greater mobility of the particles of hydrogen gas, the lightest known. It was found that this peculiar property also belonged, but to a less extent, to all the compounds of hydrogen and carbon.

A discussion followed, in which Dr. Williams, Col. York, Prof. Graham, and Mr. Hunt joined.—Prof. GRAHAM mentioned the curious fact observed by him in his researches on the diffusion of gases, that the hydro-carbons move through tubes with great velocity, and that ether vapor, which is four times the density of hydrogen, moves, notwithstanding its weight, at four times the rate of other gases. It was thought this would, perhaps, serve to indicate the path in which an explanation might be looked for.—Mr. HUNT drew attention to the fact, observed by Prof. Graham, that ether vapor had the power of preventing the combustion of phosphuretted hydrogen and of destroying the luminosity of phosphorus, and thought the phenomenon observed by Mr. Grove connected itself in some way with these curious properties of the hydro-carbons.

6. *Report on Coloring Matters;* by Dr. E. SCHUNCK, (Proc. Brit. Assoc., Athen., No. 1086.)—Having referred to the six substances which were discovered in the infusion of madder roots, and described in the last Report, the author announces the discovery of a seventh. The continued investigation of the subject has led to the conclusion, that there is but one coloring matter in madder, *i. e.*, the Alizarin; and that the substance which was thought to be a coloring matter, viz., Rubiacin, is not so. The seven substances found in the brown precipitate from the madder infusion are Alizarin, Rubiacin, Alpha-resin, Beta-resin, Rubian, Pectic Acid and Oxydized Extractive. The examination of the fluid was next made, and found to contain Xanthic acid and madder yellow. It has also been proved that madder contains sugar;—but as the process by which this is separated is somewhat tedious, we must refer chemists to the Report itself. It is known that after madder has been employed for dyeing, it still contains coloring matter, and that the article garanceux is manufactured from this. By treating this substance with boiling muriatic acid, it was found to contains lime, magnesia, oxalate of lime, phosphate of lime, alumina, and peroxyd of iron. After these salts were separated, boiling water extracted a large quantity of coloring matter which would dye mordanted cloth quite full, and of the same color as madder itself, thus showing that it contains alizarin. Alizarin is found to be composed of

Carbon, ...	56·97
Hydrogen, ...	4·19
Oxygen, ...	38·84

—or, in fact, of carbonic acid and water. Alizaric acid is formed by treating alizarin with concentrated per-salts of iron or nitric acid. The salts of this acid are mostly soluble. Alizarate of lime is prepared by

neutralizing alizaric acid with carbonate of lime, and evaporating to crystallization. It crystallizes in prisms possessing great brilliancy. Alizarate of baryta, prepared in the same way by means of carbonate of baryta, cystallizes in silky needles. Alizarate of silver, prepared by double decomposition, is soluble in boiling water, from which it crystallizes as the solution cools. Alizarate of lead is insoluble. By subjecting alizaric acid to heat, it is volatilized, and forms a sublimate in the shape of long white needles, to which the name of pyro-alizaric acid is given. By the solution in water, pyro-alizaric acid appears to be again converted into alizaric acid. Rubiacin was found to be C_{31}, H_9, O_{10}, and Rubiacic Acid C_{31}, H_9, O_{16}. Alpha and Beta resin were next examined, as were also the other constituents: and the author then proceeded to examine the part which each material plays in the process of dyeing: from which it is satisfactorily proved that alizarin is the substance producing the color; and the advantages of converting madder into garancin consists in removing the resins and those bodies which are not only useless but injurious, and in separating alizarin from those salts with which it is in the madder root in close combination.

7. *On the Alloys of Tungsten with Copper and other Metals;* by Dr. Percy, (Proc. Brit. Ass., Athen., No. 1086.)—Since the introduction of some processes by which tungsten has been separated from its ores, and from its combination with tin and other metals in nature, numerous experiments have been made with the hope of employing it usefully. From the peculiar nature of tungsten it has been thought that it would have the property of giving greater hardness to the metals with which it might be alloyed, and also of protecting them from oxydation. It was with this hope that Dr. Percy made an extensive series of experiments,—alloying copper, brass, German silver, and other metallic bodies with tungsten. In no case, however, has the result been of a satisfactory character.

8. *Analysis of Wrought Iron produced by Cementation from Cast Iron;* by Prof. Miller, (Proc. Brit. Assoc., Athen., No. 1086.)—It is to be noticed that considerable change in the specific gravity occurred in the iron after cementation: it was forged, and then found to have increased in density; the brittle iron had a specific gravity of 7·684, the malleable 7·718. The results of analysis were briefly these:—the quantity both of carbon and silicon are materially diminished by the cementation, though still the proportion of both is materially greater than in good bar iron. It also appears that the portion of carbon which is insoluble in acids is partly the same both before and after the iron has been rendered malleable, the diminution being confined almost to that portion of carbon which was chemically combined with the metal, and which, therefore, would be in a state for propagation through the mass more readily by cementation.

9. *Gutta Percha*, (Proc. Brit. Assoc., Athen., No. 1086.)—Mr. Whishaw read a paper giving an explanation of the various applications of gutta percha; numerous specimens of which, in the shape of thread, cord, tubular staves, driving bands, constables' staves, sticks, whips, inkstands, medallions, shields, water buckets, stereotype plates, and almost every other description of article, both useful and ornamen-

tal, were present. The paper, after stating that gutta percha was the concrete juice of a large tree of the same name, abounding in Borneo, &c., obtained by tapping the tree periodically by the Malays, stated that its introduction into this country was purely accidental; Dr. Montgomery having transmitted the first sample of it to the Society of Arts in 1843, at which time he (Mr. Whishaw) was secretary to that Society. The first articles of use made of gutta percha in this country were laid before the Society of Arts in 1844, and consisted of a lathe-band, a short length of pipe, and a bottle-case, which he had himself made by hand, having caused the concrete substance to become sufficiently plastic by immersing it in hot water. He also produced casts from medals, which attracted considerable attention at the time, and surgical instruments were soon after made of this new material. It was also adapted to commercial uses; and from the period mentioned to July 11th in the present year, between six hundred and seven hundred tons had been imported for the Gutta Percha Company. From twenty to sixty tons were now regularly imported every month. Contrary to the general opinion that gutta percha is a simple, hydrogenous substance, Mr. Crane (chemist to the Gutta Percha Company) found it in its ordinary state to consist of at least two distinct materials, besides a notable proportion of sulphur—viz., 1. A white matter, gutta percha in its pure state; 2. A substance of dark brown color. Various experiments were made to ascertain its strength when mixed with other matters, and also as to what pigments would mix with it without rendering it brittle or deteriorating its qualities. From these it appeared that the only pigments that could altogether be relied on to be used with gutta percha were orange lead, rose pink, red lead, vermilion, Dutch pink, yellow ochre, and orange chrome. Under the influence of heat and pressure, gutta percha would spread to a certain extent, and more so if mixed with foreign matters. All the mixtures composed of gutta percha and other substances which had been subjected to experiment, except that containing plumbago, were found to increase its power of conducting heat; but in its pure state, gutta percha was an excellent non-conductor of electricity. The best composition for increasing the pliability of gutta percha was that formed in conjunction with caoutchouc tar, and next in order that of its own tar; and the best material at present known for moulding and embodying was obtained by mixing gutta percha with its own tar and lamp-black.

In describing the process of manufacturing gutta percha, the author observed, that rude blocks of the material were first cut into slices, by means of a cutting machine formed of a circular iron plate of about five feet in diameter in which there are three radical slots furnished with as many knives or blades. The blocks are placed in an inclined shoot, so as to present one end to the operation of the cutters. The slices are then placed in a wooden tank, containing hot water, in which they are left to soak until found in a plastic state. They are afterwards passed through a mincing cylinder, similar to that used in paper mills for the conversion of rags into pulp, and then thoroughly cleansed in cold water tanks; the water, in cases of impure gutta percha, being mixed with a solution of common soda or chlorid of lime. It is next put into a masticating machine, such as is used in the manu-

facture of caoutchouc, and then pressed through rollers; thus being converted into sheets of various width and thickness. When necessary, the sheets are again masticated, and again passed through rollers. These sheets are subsequently cut into boards by vertical knives, placed at the farther end of the table, along which the sheets are carried by a cloth or web to another roller, round which they pass, and are cut into the required widths. The bands or straps are then removed, and coiled up ready for use. Driving bands for machinery are thus made, and shoe soles and heels are stamped out of similar sheets of gutta percha.

In making tubes or pipes, either of gutta percha or any of its compounds, a mass of gutta percha, after being thoroughly masticated, is placed in a metal cylinder furnished with a similar piston, by which it is pressed down into an air box, kept hot with steam, which has at its lower end a number of perforations, through which the plastic material is forced into a cup, whence it passes out, round a core, into the desired tubular form, and thence through a gauge to the required size, and into a receiver of cold water, being drawn to the other end of a long trough by a cord passing round a pulley at the far end of the trough, and returning to the person in attendance on the machine, who gradually draws the pipe away from the air machine. Thus tubes of considerable length and diameter are made to a very great extent, and are used for the conveyance of water and other liquids, and are now under test for the conveyance of gas.

The paper next explained the variety of articles already made of gutta percha, which were of three classes—1. Useful; 2. Ornamental; and 3. Useful and Ornamental combined. Various articles were then exhibited, including two very handsome shields, and a splendid Communion Dish and Service.—Mr. Whishaw next exhibited the Telakouphanon, or Speaking Trumpet; and in doing so, said that speaking tubes of gutta percha were quite new, as was also the means of calling attention by them of the person at a distance, which was accomplished by the insertion of a whistle, which, being blown, sounded at the other end quite shrilly. Attention having been thus obtained, you remove the whistle, and by simply whispering, the voice would be conveyed quite audibly for a distance of at least three quarters of a mile, and a conversation kept up. It must be obvious how useful these telegraphs must become in large manufactories; and indeed in private houses they might quite supersede the use of bells, as they are so very cheap, and by branch pipes could be conveyed to different rooms:—and, indeed, if there were no electric telegraphs, they might, by a person stationed at the end of each tube of three quarters of a mile or a mile, be made most speedily to convey intelligence for any distance. In private houses the whistle need not be used, but a more musical sound could be produced.

He then amused the auditors by causing the end of the tube, which was of the length of 100 feet, to be inserted into the mouth-piece of a flute held in a person's hand, regulated the notes, and placing his own mouth to the other end of the tube, 'God save the Queen,' was played at a distance of 100 feet from the person giving the flute breath. Turning to the Bishop of St. Davids, he said that in the event of a clergyman having three livings, he might, *by the aid of three of these*

tubes, preach the same sermon in three different churches at the same time.—Mr. Whishaw also exhibited the gutta percha submarine rope or telegraph; which consisted of a tube perforated with a series of small tubes, for the conveyance of telegraphic wire, and which, for the purpose of preventing its being acted upon by sea water or marine insects was banded or braided round by a small rope, and its being perfectly air-tight, would render it quite impervious to the atmosphere.

10. *Report on the Air and Water of Towns;* by Dr. Smith, (Proc. Brit. Assoc., Athen., No. 1087.)—In commencing his report the author says, it has long been believed that air and water have the most important influence on health,—and superstitions have therefore constantly attached themselves to receptacles of the one and emanations from the other. The town has always been found to differ from the country: this general feeling is a more decisive experiment than any that can be made in a laboratory. The author proceeds to examine all the sources from which the air or water can be contaminated. The various manufactories of large towns, the necessary conditions to which the inhabitants are subjected, and the deteriorating influences of man himself are explained. If air be passed through water a certain amount of the organic matter poured off from the lungs is to be detected in it. By continuing this experiment for three months, Dr. Smith detected sulphuric acid, chlorine, and a substance resembling impure albumen. These substances are constantly being condensed upon cold bodies, and in a warm atmosphere the albuminous matter very soon putrifies and emits disagreeable odors. The changes which this substance undergoes by oxydation, &c., were next examined,—and shown to give rise to carbonic acid, ammonia, sulphuretted hydrogen, and probably other gases. The ammonia generated fortunately from the same sources as the sulphuretted hydrogen, materially modifies its influences. The consequences of the varying pressure of the atmosphere have been observed; and it is shown that the exhalations of sewers, &c., are poured out in abundance from every outlet when the barometric pressure is lowered. By collecting the moisture of a crowded room by means of cold glasses and also dew in the open air, it was found that one was thick, oily, and smelling of perspiration, capable of decomposition and production of animalcules and confervæ,—but the dew beautifully clear and limpid. Large quantities of rain-water have frequently been collected and examined by Dr. Smith; and he says, —I am now satisfied that dust really comes down with the purest rain, and that it is simply coal ashes. No doubt this accounts for the quantity of sulphites and chlorids in the rain, and for the soot, which are the chief ingredients. The rain is also often alkaline,—arising probably from the ammonia of burnt coal, which is no doubt a valuable agent for neutralizing the sulphuric acid so often found. The rain-water of Manchester is about $2\frac{1}{4}°$ of hardness,—harder, in fact, than the water from the neighboring hills which the town intends to use. This can arise only from the ingredients obtained in the town atmosphere. But the most curious point is the fact that organic matter is never absent, although the rain be continued for whole days. The state of the air is closely connected with that of the water; what the air contains the water may absorb, what the water has dissolved or ab-

sorbed, it may give out to the air. The enormous quantity of impure matter filtering from all parts of a large town into its many natural and artificial outlets, does at first view present us with a terrible picture of our underground sources of water. But when we examine the soil of a town we do not find the state of matters to present that exaggerated character which we might suppose. The sand at the Chelsea Water-works contains only 1·43 per cent. of organic matter after being used for weeks. In 1827, Liebig found nitrates in twelve wells in Giessen, but none in wells two or three hundred yards from the town. Dr. Smith has examined thirty wells in Manchester, and he finds nitrates in them all. Many contained a surprising quantity and were very nauseous. The examination of various wells in the metropolis showed the constant formation of nitric acid; and in many wells an enormous quantity was detected. It was discovered that all organic matter, in filtrating through the soil, was very rapidly oxydized. The presence of the nitrates in the London water prevents the formation of any vegetable matter; no vegetation can be detected, even by a microscope, after a long period. The Thames water has been examined from near its source to the metropolis, and an increasing amount of impurity detected. In the summary to this Report, Dr. Smith states that the pollution of air in crowded rooms is really owing to organic matter and not merely carbonic acid; that all the water of great towns contains organic matter; that water purifies itself from organic matter in various ways, but particularly by converting it into nitrates,—that water can never stand long with advantage unless on a large scale, and should be used when collected or as soon as filtered.

11. *On the Manufacture of Ice.*—Ice at the present day is considered one of the necessaries rather than one of the luxuries of life. Unfortunately those parts of our country where it is most needed are without the means of regular supply. The inland portions of the southern and south-western States, do not get the benefit of the ice trade from the north, the natural ice crop is precarious or altogether wanting, while the heat of summer untempered by the sea breeze makes ice one of the greatest comforts of life.

The manufacture of ice is therefore likely to become a great desideratum and already much has been said on this subject in the papers. It appears that some plan has been devised although no description of the process has been published. As much that is erroneous has been stated, we have thought it worth while to give the results of an actual trial of well known methods.

In France, freezers are used for making ice, ice creams, &c., by the use of several frigorific mixtures, and these freezers are probably to be met with in several of our larger cities. Two different forms have been exposed for sale in the city of New York. The mixtures most recommended for use are crystallized sulphate of soda drenched with muriatic acid, or nitre salammoniac and water. The former of these would in most places be a costly mixture, and while unsafe in careless hands, and destructive to the vessels likely to be used, could not be employed without loss, as it would be impossible to recover the acid when the solution was evaporated. The solution of nitre and salammoniac is liable to none of the objections—the salts are not costly, and

the evaporation can be conducted with very little loss. This is accordingly the process recommended by the inventors of the freezers above mentioned. A Committee of the Society for Encouragement of the Arts at Paris, reported favorably upon the apparatus of M. Goubaud. The salts are not named, but are undoubtedly those above mentioned. To make one pound of ice, about five pounds of the salts with five pints of water were required—the duration of the process fifteen to eighteen minutes. The loss of the salts amounted to not quite one per cent., cost 1·7 cents; the fuel for evaporation, charcoal, at Paris prices, four cents, making the pound of ice cost 5·7 cents or say 6 cents. The chief part of the expense being for the fuel, it is manifest that ice may be made most cheaply where wood or coal costs least. A part of the fuel may be saved by evaporating as far as possible by the heat of the sun; hence the hotter and drier the atmosphere, *cæteris paribus*, the less the cost of the ice.

In the report quoted above, the committee admit that by these and other expedients the cost may be greatly reduced from that named, which it must be remembered is for the city of Paris where fuel is very dear. In most of the southern and southwestern States, the price of fuel is such as to reduce the cost of evaporations to less than one cent for one pound of ice, being in all two and a half to three cents per pound. The loss in the salts could easily be avoided, wholly or in part, and this would reduce the price to less than two cents. But this is not all. The cold liquor resulting from the solution of the salts may be advantageously employed in cooling provisions, &c., and in the contrivances for this purpose, are found the chief difference between the French freezers and those in common use.

It is hardly necessary to state that the widely circulated story that ice can be produced artificially for one dollar per ton, must be an utter absurdity. The naturally formed ice costs at least as much as this by the time it is housed, and that formed artificially must require as much if not more handling.

Sulphate of soda may be added to the mixture of salammoniac and nitre, but we know of no experiments upon its use on the large scale.

G. C. Schaeffer.

12. *Composition of the Tungstates;* by A. Laurent, (Journ. de Pharm. et de Chim., Jan., 1848.)—A study of the properties of these salts has led to the conclusion that they do not all contain the same acid. M. Laurent enumerates five or six of these acids which form ammoniacal salts having different properties, and which when calcined leave an anhydrid having the same per-centage composition, yet are capable each one of regenerating its own acid or ammonia salt.

The first type is the *tungstic** $WO_4\ M_2$ with or without *aq.* To this type belong most of the insoluble tungstates: also the yellow acid $WO_4\ H_2$ obtained by treating wolfram with aqua regia. This acid is very soluble in ammonia, but on evaporation the ammonia salt of the next type is formed.

2d type, *Paratungstate.* This includes most of the common bitungstates; the anhydrid is $W_4\ O_{12}$, as that of the last is WO_3.

* We retain M. Laurent's notation $M_2\ H_2\ Ka_2$ and being equal to M, H, Ka.

The anhydrated acids are $W_4 O_{14} H_4$; another +2aq.; another +8aq. There is also a number of ammonia and double salts, some of them of great interest, having singular peculiarities in their crystalline forms.

3d type, *Metatungstate.* The action of nitric acid, brings the ammonia salt of the last type into this. This salt forms octahedrons; the acid itself is very soluble. The formula for the type is $W_3 O_{10} M_2$.

The anhydrid obtained at a dull red heat produces with ammonia a salt of the next type; the metatungstate of ammonia does the same.

4th type, *Isotungstate.* $W_2 O_7 M_2$; the anhydrid is $W_2 O_6$, and this again is capable with ammonia of reproducing an isotungstate.

5th type, *Polytungstate.* About this there is some uncertainty. The acids $W_6 O_{21} H_6$ and also +2aq. have been analyzed. The anhydrid is $W_6 O_{18}$. There is some probability of the existence of still another type.

These very curious researches are worthy of being followed up, particularly with the ethers which may be formed by their acids.

G. C. S.

13. *On the Crystallization of Sulphur;* by M. S. Pasteur, also by M. Ch. Deville, (Comptes Rend., Jan., 1848.)—M. Pasteur has found sulphur crystallized from its solution in sulphuret of carbon to present the two different forms—the octahedrons usually formed, and also the form obtained by fusion, an oblique rhombic prism—but in this case unmodified.

M. Deville has noticed that the soft red sulphur may be remelted, and cooled either slowly or rapidly without losing its reddish brown color. The prisms obtained by fusion undergo the same changes as to opacity, increase of density, &c., as usual. Still more singular, the solution of this red sulphur in sulphuret of carbon, retains the color, and the crystals formed are in part octahedral, more or less red, by having the colors unequally distributed in part—red prisms changing as usual—and also a portion of amorphous sulphur deeply colored and remaining viscous for a long time. These investigations have a very curious bearing upon the allotropism of sulphur, noticed by Mr. Hunt in a late number, and upon the fact mentioned in the researches of M. Leconte, on the action of sulphuretted hydrogen upon nitric acid*—that the sulphur precipitated without heat, had the soft or elastic condition, commonly obtained by pouring melted sulphur (at a certain temperature) into cold water.

G. C. S.

II. Mineralogy and Geology.

1. *Examination of the Telluret of Bismuth, from Virginia;* by Coleman Fisher, Jr., (in a letter to the Editors, dated Philadelphia, December 26th, 1848.)—In the September number of your Journal, Dr. C. T. Jackson has described a tellurium ore from White Hall mine, Spotsylvania county, Virginia. Having received a small quantity of the ore from Prof. R. S. McCulloh of the U. S. Mint, I subjected it to

* See this Journal for March, 1848, p. 261.

a thorough analysis in the laboratory of Prof. J. C. Booth. I subjoin a description and the analysis.

Description.—Foliated, without any appearance of regular crystallization, the laminæ not elastic. Color between lead gray and steel gray; lustre metallic shining; H.=2; sectile; soils paper slightly.

On charcoal it fuses readily, tinging the flame blue, forms a white coating tinted red on the edge, and gives the odor of selenium. In an open tube, it fuses emitting the odor of selenium, forming a red sublimate of the same, and gives off white fumes, while a fusible yellowish white sublimate of tellurous acid is formed, the residue being brownish white.

Analysis.—It was dissolved in nitro-muriatic acid, evaporated to expel the nitric acid, partially neutralized by ammonia, and precipitated by an excess of sulphydrate of ammonium, with which it was digested to dissolve the tellurium. The latter was determined by solution in acid, and precipitation by sulphurous acid, which was repeated in order to obtain all the tellurium. To separate the selenium from the tellurium, the metal was treated with nitric acid, fused with carbonate of soda and saltpeter, again treated with an excess of nitric acid and precipitated by nitrate of baryta, which throws down seleniate of baryta, insoluble in a nitric solution. The metal can be perfectly isolated, and presented in the metallic state by means of sulphurous acid. The bismuth and iron were separated by sulphuretted hydrogen, and the former determined as oxyd. The silica contained traces of tin, and a minute trace of gold. The following are the results of the analysis of 19·96 grains.

		In 100 parts.	
Bismuth,	10·31	51·65	54·81
Tellurium,	7·14	35·77	37·96
Selenium,	1·36	6·81	7·23
Iron,	0·25	1·25	. .
Silica,	0·77	3·86	. .
	19·83	99·34	100·00

The iron and silica being thrown off as impurities; the per-centage calculation of bismuth, tellurium, and selenium, are contained in the third column. Assuming the oxyd of bismuth as $Bi\,O_3$, when the equivalent of Bi is 213, it is evident that we have a tertelluret of bismuth $Bi\,Te_3$, in which a portion of the tellurium is replaced by selenium; for regarded as $Bi\,Te_3$, the 37·96 of tellurium requires 42·11 bismuth, and 7·23 selenium requires 12·83 bismuth; and 42·11+12·83=54·94 bismuth, which is almost precisely the amount found by analysis. The mineral is therefore similar to the telluret (Tetradymite) found in Hungary, but is a telluret and selenuret, instead of being a telluret and sulphuret. Its approximate formula is $Bi\,Se_3+3\,(Bi\,Te_3)$; or putting the selenium and tellurium together the formula is $Bi\,Te_3$.

2. *Emery Formation of Asia Minor;* by J. Lawrence Smith.—The following communication, received in a letter from Dr. Smith, dated Constantinople, January 5, 1849, is a translation of a communication addressed by him to Elie de Beaumont.

These lines are written with reference to an extract of a letter from M. Pierre de Tchihatcheff, published in the *Comptes Rendus de l'Académie des Sciences*, the 20th of March, 1848. It is only lately that my attention was attracted by this letter, more especially by the last phrase, ("I have communicated all the necessary indications to Mr. Lawrence Smith, American Mineralogist, in the service of the *Porte*, and he proposes *to develope my discovery*,")—because in reading this it would appear that I was entirely ignorant of the existence of the emery alluded to, in Asia Minor, and that the first information given me was by M. Tchihatcheff, on returning from his voyage in December, 1847. I wish in no way to affect his right to the observations upon the Emery which he found between *Eskihissar* and *Melas* in December, 1847—situated more southerly than any of the localities to which my own observations had extended; but I am equally desirous to have my own discoveries attributed to me.

It was in the month of November, 1846, that a merchant in Smyrna showed me specimens of emery said to come from *Kula*, (about eighty miles east of Smyrna.) The importance of this mineral led me early in 1847, to visit Smyrna, for the purpose of investigating this matter. On my second visit to this city, I was shown other specimens coming from the neighborhood of Epheseus, and which being nearer than *Kula*, I at once visited. About twelve miles to the east of Ephesus, near to the village of *Gumuchkeny* and on the summit of *Gumuchdagh*, I discovered emery *in situ;* however, before arriving there I saw this same mineral more or less scattered over the country. The Turkish government, to whom I communicated the importance of this discovery, sent a commission with me to examine the region in the *month of May*, 1847, a fact which was announced *publicly* in the *Journal of Constantinople* the 16*th of May*, 1847, in the following words:—

"It is some time since Monsieur le docteur Smith, American Mineralogist, of whom we have had frequent occasion to speak, discovered at Magnesia, near to Gumuchkeny, an *emery mine*, and of which he brought specimens to Constantinople. The government has sent to the place a commission composed of Dr. Smith and some of the officers of the Imperial powder works, to examine thoroughly into the importance of this mine, and according to the report that will be made, the government will decide on the steps to be taken with reference to it," &c.

On our return and after we had made our report on the developement of the emery formation in three distinct places, distant from each other, to wit, in Gumuchdagh; near to Kula; and to the north of Smyrna; the monopoly of this mineral was offered for sale, and purchased first by Mr. Langdon of Smyrna, and subsequently by the house of Abbott & Co., for the sum of twelve hundred thousand piastres per annum (fifty-five thousand dollars), and about the month of August some eight hundred tons from the summit of Gumuchdagh were in England. Thus when M. Tchihatcheff thought to have discovered this emery for the *first time in situ*, in December, 1847, and when he wrote to you the following words: "The brilliant prospect that Asia Minor presents in reference to this mineral, and which I am happy to have first pointed out," &c., and at the end—"I have communicated the necessary indications to Mr. Lawrence Smith, American Mineralogist, in the service of the *Porte*,

who proposes to develope my discovery." I say, when this was written to you, already near a year had expired since I had made the discovery; it was publicly known by the announcement in the Journal of Constantinople, the 16th May, 1847, and the "brilliant prospect" was already appreciated by the Turkish government, and eight hundred tons from the summit of Gumuchdagh were in England. Wherefore I claim the priority of the discovery of emery in Asia Minor, *in situ*, and to have been the first to have made known publicly this discovery.

The reason why I did not make this discovery known to the scientific world, was, because I intended to make a complete memoir on this subject after an examination of certain points, which is not yet finished; I will mention only one or two to which my investigations have led me; they are the discovery of the existence of the oxyd of zirconium in emery, and of a new mineral that I have found associated with emery coming from all the localities of Asia Minor and of Naxos. It is a micaceous mineral having for composition, silex 30, alumina 50, zirconia 4, lime 13, oxyd of iron, manganese and potash 3. I have decided to call it *Emerylite*, and to give at some future time a full description of it.

One word upon the aspect of emery, which M. Tchihatcheff has compared to the hydrated oxyd of iron. In all my observation, I have not yet seen a specimen that can be compared to this oxyd; even at first sight it resembles more nearly the protoxyds, the silicates and *anhydrous* oxyds of iron. The fracture is irregular, except in a species of inferior quality from Gumuchdagh, which has a conchoidal fracture and the aspect of black limestone. I have made other observations more or less interesting but I reserve them for another time.

3. *Chrome and Meerschaum of Asia Minor;* by J. Lawrence Smith, (communicated with the preceding.)—In my journey to the south of Broosa, (Anatoly, Asia Minor,) I crossed a formation of serpentine and other magnesian rocks of considerable extent. Fifty miles from this city I discovered *chromate of iron* disseminated in these rocks; and ten or fifteen miles farther south (near the city of Harmanjick) there is an abundant deposit of this mineral. A circumstance worthy of remark, is, that this chromate of iron (the first that has been discovered in Asia Minor) is found in serpentine as elsewhere. This important fact can explain to a certain extent the formation of this chromate. It is well known that serpentine contains all the elements of chromate of iron, which, during the consolidation of this rock, might separate themselves by the force of segregation, so well known to operate in many geological phenomena. Two facts which seem to confirm this supposition, are, first the existence of the chromate of iron in masses and not in veins, and secondly, the pale color of the serpentine associated with the chromate. One small specimen that I have, consists of a white rock, composed principally of carbonate of magnesia in which small specks of chromate of iron are visible. It is possible that this carbonate is the result of the decomposition of the serpentine at the surface, by the action of water containing carbonic acid. It is only at this locality that I found crystals of the chromate, octahedral, but very small.

This discovery is of great importance to the arts and to the Turkish government, which proposes exploring the mine.

In quitting the locality of chrome, and going northeast, I traversed in several places the serpentine containing veins of carbonate of magnesia, quite pure; and this occurs until we arrive at the plains of *Eskihi-sher*. It is from different parts of this plain that comes the meerschaum most esteemed in the arts. Its geological position is very different from what I had expected. The plain in which it is found is a deposit of drift; a valley filled up with the *debris* of the neighboring mountains, consolidated by lime in which I found no fossils.

The meerschaum is found in this drift in masses more or less rounded, the other pebbles are fragments of magnesian and hornblende rocks.

I have examined with care the neighboring mountains which surround the plain, and have found that the rocks are of the same nature as the pebbles in the plain, except those of the meerschaum; but on the other hand, I found carbonate of magnesia in the mountains which is not to be found in the plains. And this makes me suppose that the meerschaum owes its origin to the carbonate of magnesia of the mountains, decomposed after its separation by water containing silica.

If this supposition be true, we should naturally find meerschaum which not being completely altered, contains the carbonate of magnesia. A chemical examination of several specimens has served to establish this fact. I have the honor to send you a specimen taken at the depth of ten feet—and if you desire to make the experiment yourself, put a small piece of the specimen, well cleaned, in hydrochloric acid, you will have immediately an effervescence which will continue for some time; the piece will not change its form, it only absorbes the acid; the solution will be found to contain chlorid of magnesium nearly pure. Another proof that the meerschaum probably owes its origin to the carbonate of magnesia is, that I have found attached to the meerschaum, serpentine similar to that found in contact with the carbonate of magnesia of the mountains.

The meerschaum of *Eskihi-sher* differs completely from several other specimens that I have seen coming from the localities and which exist in the fissures of rocks—it is certain that the quality of the first is most esteemed.

4. *Axinite in Maine.*—Dr. T. N. True says in a letter to one of the Editors, "I have a good and well defined specimen of axinite in crystallized quartz from the town of Wales, Me.; but although the quartz is in place I could find but a single specimen of this rare mineral.

5. *Copper of the Lake Superior Region*, (from a recent letter by C. T. Jackson.)—The native copper mines of this region are truly wonderful, both for the quantities that are exposed in the mines and the magnitude of the masses of native metal. Truly they are *copper veins.* I have seen the most noble lumps in place, and one has lately been blown off in stoping in the Cliff mine, Eagle river, that will weigh fifty tons! It is now cutting up into pieces of two or three tons weight, so that it may be sent to market. The supply furnished by that mine is as regular as it is in most mines furnishing ore. This spring the miners had four hundred tons on hand, and they have sent down to

Baltimore six hundred tons at this time, and they estimate the amount of copper that they will ship at from nine hundred to one thousand tons before the close of navigation in November next. This mine has been wrought with proper energy, and will richly repay the owners. There are several other native copper mines here that are equally promising, and will produce well when wrought with proper energy and skill.

Copper Falls mine is an example, and is doing well. The Northwest is another full of promise, and I have seen others which look very rich, but which are not yet opened deep enough to exhibit their contents. The shafts at the Cliff mine are 205 feet deep, and the hill above shows the vein in the face 213 feet higher, so that we know that the copper extends at least 418 feet. Those who were surprised that I recommended working mines for *native* copper, should come and see and they would believe. The case is indeed a new one, and we watch with interest the results.

Native silver is found mostly at and near the junction of the trap and sandstone where the veins end, not passing into the sandstone.

6. *Observations on the "Old Crater" adjoining Kilauea, (Hawaii,) on the east;* by Rev. C. S. Lyman, (from a letter dated Upper California, January 30, 1848.)—The "Old Crater" is a pit a mile in diameter, and five hundred or six hundred feet deep, separated from the present active crater by an isthmus of earth, about a quarter of a mile in width. I spent a day ransacking it. The bottom is covered with lava in thick strata resembling ice left in the bottom of a pond after the water has been drawn out. This covers an area three-quarters of a mile in diameter, and rises around the sides of the bowl-like concavity some forty or fifty feet above the level of the bottom. I noticed projecting perpendicularly from the bottom, a great number of stone pillars of various sizes, from one to two feet, and of heights from one to twenty feet. On breaking off some of them I found them tubular and filled with charcoal. The specimen in the box is a portion of one of these tubes with the lava injected into the seams of the charcoal. I could conveniently bring away only this specimen, hoping to get more at another visit which has not yet occurred. The philosophy of this specimen I take to be this. At some comparatively recent period, the lava burst out far up the sides of this pit and even upon the neck of land between the two craters and flowed down into the bottom—at that time a forest—filling it up to the depths of forty or fifty feet, with a lake of lava.* The lava in contact with the trees, would be cooled at once into an encasement of stone from two to six inches in thickness, while the rest of the mass remained fluid. The trees would of course be almost instantly reduced to charcoal, and a crust often a foot or so in thickness must have cooled on the surface of the lake. The lake must then have been drained off subterraneously, while the crust descending, like the ice on a pond when drawn off, would be pierced by these solid encasements of the trees, and finally lie scattered over the bottom in huge cakes, as ice would among stumps on the bottom of the pond, leaving these curious tree-encasements projecting as they now do.

* In 1832. See Geol. Rep. Expl. Expedition by J. D. Dana, pp. 186, 211.

III. Zoology.

On the Boring of Mollusca into Rocks and on the removal of Portions of their Shells; by Mr. A. Hancock, (Proc. Brit. Assoc., Athen., No. 1086.)—The author stated that three theories had been advocated as to the way in which the mollusks effect their entrance into the rocks, &c., in which they are found. The first is, that the animal works with the shell in the manner of a rasp or an auger. The second, that it secretes an acid whereby the substance with which it comes in contact is dissolved. The third, that the effect is produced by the vibratile action of the parts exciting constant currents of water against the substance, aided by its impetus when drawn in down the elongated body of the animal. The author objected to all these theories. In opposition to the first, he stated that the burrows are tortuous and of a form to render it impossible that the valves of the shells should act as a centre-bit or auger. Again, the spines that cover many of the shells are covered with an epidermis which, if the shells were used for boring, would be rubbed off—which is not the case. The young of these creatures commence boring directly they are hatched, when their shells are too delicate to produce any effect on the substances into which they penetrate. In opposition to the theory that a solvent is employed, the author stated that this must be of an acid nature, and that by the most careful experiments he had been unable to detect the slightest indication of any acid secretions from any part of the bodies of these animals. Besides, if a solvent were secreted capable of dissolving calcareous and sandstone rocks, ought it not also to act on the shell of the animal?—which was found not to be the case. The physical appearances of the excavation, also, were not like those produced by a solvent. It would not account, either, for their boring in wood. The wood found in the stomach of the *Teredo navalis* was found to be chemically unchanged. The theory of the ciliary currents was objected to on the ground that it was inadequate to explain the phenomena. If these delicate ciliary currents were capable of effecting this object, the dashing of the water over the same surfaces ought to have as much more effect as their physical force is greater. The anatomical structure of the part, also, on which the cilia are situated would forbid the supposition that currents produced by them could effect this object. These theories being insufficient to explain the phenomenon, the author proposed a new one. He believes that the anterior portion of the animal is the excavating instrument. This, in *Teredo* and *Pholas*, is composed of the foot and edges of the mantle, which together fill up the frontal gape of the shell. In *Saxicava* and *Gastrochæna* it is formed wholly of the edges of the mantle, which are united and thickened. The form of the excavation corresponds to the form of these organs. On a minute examination of the surface of the foot of *Teredo Norwegica* it is found, under the microscope, to be crowded with minute brilliant points, which on being compressed, consist of comparatively large crystalline bodies embedded within them. These crystals are numerous and of various sizes and shapes, chiefly five and six-sided, but not by any means regularly so. They all agree in hav-

ing one or more elevated points near the center. These bodies are highly refractive, and are for the most part pretty regularly distributed over the whole convex surface of the foot, but are occasionally congregated into masses. Similar crystalline bodies are embedded in the edges of the mantle surrounding the foot. In *Pholas* the same appearance is presented both in the foot and the surrounding edges of the mantle. *Saxicava rugosa* has also the anterior portion of the animal abundantly provided with crystalline bodies like those already described; so also with the foot and mantle of *Patella vulgata*. These bodies are constantly being shed. Acetic acid has no effect on them; and in *Saxicava*, strong nitric acid produces no change after several days' immersion. Those of *Pholas* and *Teredo* appear to be ultimately acted on by this acid, but are never totally destroyed by it. It is by means of these bodies that the author believes the animal rasps down the substances in which they are found. The whole of these animals are also supplied with powerful muscles by which they may effect the necessary movement for the production of this result. Judging from analogy, the author believes that all the boring mollusks excavate in the same manner; none by the rasping or cutting of their valves, none by a solvent, none by ciliary currents. In the same manner he accounts for the gradual disappearance of certain portions of the columella in the gasteropodous Mollusca; not by the process of "absorption," as has been supposed.

Mr. PHILLIPS explained more fully the nature of the boring process carried on by these animals, and thought the author of this paper had thrown much light on the subject. Granules on the tongue of many of the Mollusca had been long known. They appeared to be of a siliceous character.—Prof. OWEN stated that there was no *à priori* objection to the theories opposed by the author, and one or another had been adopted by naturalists to explain the phenomenon of boring. At the same time, the inadequacy of these theories for the explanation of some cases had led him to regard the foot and mantle as engaged in the operation,—how, he now, for the first time, was informed. He still, however, thought that an exception ought to be made in the case of *Pholas navalis*, which he yet believed must burrow in wood by means of its shell.—Prof. E. FORBES said that having to write on this subject in his "History of the British Mollusca," he had carefully gone over the evidence in favor of all the views adopted, and was not unaware of those of the author. He found little evidence to support the theory of a solvent being employed, or of the agency of ciliary currents; but he found as little in favor of the siliceous particles of the author. He had carefully examined *Saxicava*, and could find no siliceous granules. Mr. Henfrey had examined these creatures under the microscope, and had failed to detect anything of the kind. A chemical examination made by Mr. Henry had also failed to detect them. He did not deny that they might be present in *Clavagella*. Under these circumstances, he had endeavored to take an eclectic view of the subject. The different substances into which these animals penetrated might require different means. Some species of the genus *Pholas* bored in wood, some in stone, but none in both.—Mr. HANCOCK had referred to a species of sponge, the *Clione*, as a borer. This animal was undoubtedly irritable,

but he doubted if it made itself the holes which it occupied.—Mr. Bowerbank could bear testimony to the irritability of *Clione*, but he did not believe that it bored. He believed it to be a true sponge. It had spiculæ and tubes like a *Halichondria*. With regard to the application of the author's theory to the absorption of the columella of shells, he did not think it was necessary, as the researches of Dr. Carpenter and himself had shown that the shells of the Mollusca were organic and susceptible of absorption.—Dr. Carpenter had seen in the borders of the mantle of Terebratula, siliceous particles in the form of spines. It was not necessary that the granules should be silex, as any hard substance would be sufficient for the purpose. He had seen Pholades in such a position in an excavation, as to render it impossible that they should have turned round for the purpose of boring.—Mr. Jeffreys stated that he had observed that the tongues of many forms of Mollusca were constantly renewed in the manner mentioned by the author as occurring with the siliceous granules.—The President drew attention to a fact stated by Mr. Osler in his paper in the *Philosophical Transactions* on the boring of mollusks, that in one instance he had observed that the *Saxicava rugosa*, in boring through a calcareous rock, had been arrested in its course by a layer of argillaceous matter, thus lending great support to the solvent theory.

IV. Astronomy.

1. *Denial of the Discovery of the tenth asteroid, Diana.*—The announcement (in vol. vi, p. 278, Sept., 1848), of the discovery of another asteroid, Diana, by Prof. Kaiser of Leyden, proves to have been premature. The statement was derived by us from the Literary World, of July 8, 1848, which was corroborated by a paragraph in the newspapers that the announcement had been made in Schumacher's Journal. As we find no allusion to this alleged discovery in the European Scientific Journals, we cannot doubt that the statement was entirely erroneous.

2. *Ecliptic Star Charts.*—It is well known that Mr. J. R. Hind, the able Superintendant of Mr. Bishop's Observatory in London, announced a year since or more, a series of star charts comprehending all the stars down to about the tenth magnitude, within the vicinity of the Ecliptic, for the purpose among others, of facilitating the search for new planets. The first sheet, (Hour I.) accompanied with remarks and notes, was advertised for sale in January, 1849, price 2*s.* 6*d.*

V. Miscellaneous Intelligence.

1. *Observations on California;* by Rev. C. S. Lyman, (from Mr. Lyman's recent correspondence.)—I have been in the country now two months, lacking four or five days—have visited San Francisco and Monterey, and the one hundred and fifty miles of country between. A magnificent plain, one of the finest in California, stretches almost from one place to the other. On the middle portion of it I now am. You may ride hundreds of miles over land covered with stout oats growing

wild, and of course going to waste except what the cattle and horses eat. The farms in this country embrace from ten or less to fifty or one hundred square miles; of course the farm houses are many miles apart. The principal source of income to the owners is from the cattle kept on them—many herds numbering thousands of heads. Beef is very abundant, and is the Californian's life. The climate inland—e. g., in this valley where I now am, is the most delightful imaginable. During the six or eight months of the summer season there is scarcely a drop of rain or a cloud in the sky, but a pure bracing air with cool nights resembling our finest September weather in New England. You sleep under a blanket the year round—have no showers to look out for—and can take a journey of weeks or months without an umbrella. The great want here is of water, yet in agriculture it is little felt, since much of the land has sufficient natural moisture. On this farm, for example, there are thousands of acres of green grass all the year around; melons, corn, potatoes and all kinds of vegetables grow green and rank without irrigation.*

On the coast the climate is widely different. At San Francisco one dresses in woolens throughout, even in midsummer—as much so as for the coldest New England winter. There is a great deal of chilly fog, and the thermometer since I landed, July 3d, has ranged between 50° and 68°—the latter being the highest I have yet seen it in the shade, even at 2 P. M. of a bright cloudless day. You may think it almost an incredible story—and it is indeed the most wonderful climate I ever heard or conceived of.—(*From a letter, dated San Francisco, August* 30, 1847.)

During the six months I have been here there has been but little more than a week's rain, and that fell chiefly a fortnight since. The weather for two weeks and a half past and almost entirely up to that rainy week, had been mild and delightful, a cloudless sky with fine bracing air, like the clear weather of the latter part of September with us. Most of the mornings since the first of December have been frosty, and at morning and evening a fire is essential to comfort. I am now writing in a room without fire or fire-place, and with doors and windows open on two sides, and all my mapping and plotting this winter, I have done in a chamber without a fire. Snow and ice never trouble us. This is very different from your weather only four degrees north of us. —(*From a letter dated South of San Josè, January* 30, 1848.)

The immense gold deposit in the Sierra Nevada has been the prominent object of thought in California the last six months, and it will be so for years. I have visited several different parts of it. * * It is every where extremely rich. Its length along the Sierra has already been explored some four hundred miles, and rich *diggings* have been actively worked. At a moderate estimate, probably four or five millions of dollars at $16 per ounce troy, have already been taken out since the workings were first commenced about nine months ago, most of it with-

* The region here described lies south of San Josè, between ranges of the Coast mountains. It is west of the great valley of San Joachim and Sacramento, where the climate is warmer and drier.—J. D. D.

in the last four months. As the explorations proceed, the results become richer and richer; from four to six thousand people probably have been digging, and the average day's work for the whole would hardly fall short of an ounce. Five, six and ten ounces are not uncommon days' works, and some, individually, have taken out two, three, four, and even ten or more pounds of gold in a single day. I design at my earliest leisure to write a pretty full description of the *placers*, and its geological associations. Suffice it to say that the rocks of the Sierra Nevada range are primitive and metamorphic, and that the gold occurs so far as I have observed, solely in one geological position, namely, the stratum of drift or diluvium, which in places where the diggings have been carried on, varies from half a foot to several feet in thickness. The richest excavations have been in the bottoms of dry ravines, though gold is found on the slopes, and even on the summits of the hills. Single pieces have been reported as weighing fifteen and twenty pounds, but the largest I have *seen* is one at present in my keeping. It weighs between six and seven pounds troy, being composed of a large proportion in bulk of quartz rock with metallic gold interspersed,—the weight of the gold amounting probably to two and a half or three pounds.—(*From a letter dated November* 17, 1848.)

Another letter from Rev. C. S. Lyman, relating to the mines of quicksilver in California, and giving one of the earliest announcements of the discovery of gold, was published in volume vi, of this Journal, p. 270, September, 1848.

2. *Analysis of Ashes;* extract from a letter from Mr. FLEITMANN of Berlin to Prof. HORSFORD, (communicated for this Journal.)—"Every one occupied with the analysis of ashes, knows the difficulties which accompany the incineration of many substances. The escape of alkaline chlorids during the process is known to be great. Other salts are driven off or altered—especially the phosphates, which are reduced by charcoal at the high temperature necessary for combustion. Starting with the supposition that the principal cause of the difficulty of burning the charred masses arises from the envelope of fusible salts, which exclude the free access of air, I tried to improve the process by obstructing that influence. I succeeded in this by charring the substance, powdering, moistening with bichlorid of platinum, and igniting the whole in the open air. In this manner the whole substance became penetrated with a fine net work of platinum sponge. The well known property of platinum sponge, of absorbing oxygen in its pores and transferring it to combustible bodies, is here of great avail. This property shows itself in so striking a manner that frequently the charcoal prepared with platinum as indicated, when once lighted, continues in a state of ignition for hours without the application of external heat. The maximum quantity of platinum is half a gramme for ten grammes of charred substance. The separation of the platinum from the ashes is simple; one difficulty has to be opposed. In most cases where the charred substance is incorporated with the solution of chlorid of platinum, a quantity of double salts of platinum is formed, which cannot be perfectly decomposed by simple ignition. A reduction by means of hydrogen, is therefore unavoidable.

The determination of the chlorine contained in the ashes is, of course, to be made beforehand. The substance is to be charred in a well closed Hessian crucible, then completely extracted with water, and the chlorine determined from that solution. In my analyses, I used to analyze this solution by itself. I then proceeded to extract with hydrochloric acid, and analyzed this solution separately and also the residue. I did this at the request of Prof. Rosè, who on the ground of these results founds a theory which he will soon publish."

"I give below the result of my analysis of the fæces and urine of man, which I have tried to make interesting by enabling a comparison to be made between the inorganic matters they contain, and those contained in the food at the same time.

I carefully collected for four days the solid and liquid excrements of a young man. The sum of the constituents in both can without doubt be regarded as equivalent to the corresponding quantities in the food. The following quantities are calculated for the period of twenty-four hours.

	The fæces of one day contain		The urine of one day contains	
Na Cl	= 0·0167	grammes	= 8·9243	grammes.
Na O	= 0·0185	"	= ——	"
K Cl	= ——	"	= 0·7511	"
KO	= 0·5455	"	= 2·4823	"
CaO	= 0·5566	"	= 0·2245	"
MgO	= 0·2781	"	= 0·2415	"
$Fe_2 O_3$	= 0·0544	"	= 0·0048	"
PO_5	= 0·8072	"	= 1·7598	"
SO_3	= 0·0293	"	= 0·3864	"
SiO_3	= 0·0375	"	= 0·0691	"
	2·3438		14·8438	

The difference in the proportions of potassa and soda in the fæces and urine, is remarkable. The quantity of soda in the fæces is in no proportion to that which is secreted daily in the body as bile, and shows that the bile must be removed from the body by another way than the fæces."

3. *Aurora Borealis of Nov.* 17, 1848.—The display of the Aurora Borealis seen in the United States and even as far south as Cuba, (see p. 127 of this volume,) on the night of November 17, 1848, was probably as wide spread as any to be found on record. A letter from Rev. Samuel J. Parker, Ithaca, N. Y., communicates his observations, which show that the exhibition has rarely, if ever, been surpassed in these regions. I give a single extract, "At one time the circular spot south of the zenith (the corona) was the only part of the heavens destitute of the aurora; indeed for two hours most of the time, this was the case. The rays of course ran from the horizon to this spot,—from the southern as well as the northern horizon."

The same phenomenon was observed in Smyrna, Salonica and Odessa. The subjoined description of its appearance at Odessa is taken from *L'Impartial* of Dec. 1, 1848, a newspaper of Smyrna, for which I am indebted to Rev. Henry A. Homes of Constantinople. It was also observed at San Francisco, California, by Rev. C. S. Lyman,

whose interesting account of the display I extract from his letter to me, dated at the place last named, Nov. 18, 1848. E. C. H.

(1.) *Odessa*, 46° N. lat. 31° E. lon. "On Friday last, November 5, O. S. (17th), our city was favored for two hours with a phenomenon extremely rare here. A magnificent Aurora Borealis overspread a large part of the heavens. At seven o'clock the light in the north led to the supposition of a distant fire, but its continuance and mild character dissipated all doubts; it was certainly the Aurora Borealis, although faint. Towards eleven o'clock, the light hitherto diffuse, appeared in more distinct sheafs, and columns of various lengths, rising almost vertically from the horizon to the zenith, without touching either; the moving rays successively increasing and diminishing, and shooting with more and less brilliancy. At eleven this sea of white light began to assume a rosy tint, which every moment became deeper; the whole sky below Ursa Major, and to a great distance right and left, at this time presented the sublime spectacle of a vast conflagration, fed by some immense invisible city,—for the horizon below was blue, (or rather of that bluish white which is said to be a sign of cold.) Towards the zenith the moving sheafs of tinted vapor were lost in hues of purple and violet and in the deep blue of the starry sky. At $11^h\ 10^m$ the entire tail of Ursa Major was covered with the blood-red sea; five minutes later, the rosy tints gradually faded. The display seemed about to terminate, but soon passing now more to the left, below the polar star, the reddening began with still greater intensity, and covering more space than before. Still shifting from white to more vivid hues, the phenomenon continued visible until an hour and a half after midnight. During the whole time the air was calm and mild. The morning of that day had been windy and cold: between 2 and 3 P. M. some flakes of snow had fallen; the temperature became milder at evening."

(2.) *San Francisco, Up. Cal.*, 38° N. lat. 122° W. lon. "Last evening there occurred here a beautiful exhibition of the Aurora Borealis, similar to those witnessed at New Haven eleven or twelve years ago. This is the first glimpse I have had at any auroral appearance since I left the United States, [Oct. 1845.] I was at my camp on the western side of the Bay of San Francisco, eighteen miles south of this place, and in lat. 37° 37′ N., long. 122° W. of Gr. My attention was first called to the aurora about half past 6 P. M. (Friday, November 17), when the northern sky presented a beautiful display of waving colored light with a faint appearance of streamers. The prevailing red hue was in all respects similar to that of the Auroras referred to above, strongly resembling the reflection of the light of a conflagration from the clouds. In altitude the light did not reach above the pole star. The western extent of it was the handle of the Dipper, (*Ursa Major*,) and the eastern was concealed partially by light clouds which were scattered over the northern sky, the center apparently coinciding with the magnetic meridian: the declination of the needle at the place being very nearly *sixteen* degrees east. The Aurora gradually grew fainter till a little after seven, when it became entirely invisible. Being quite unwell at the time, I did not sit up to watch for its re-appearance. One of my men however who was up some time in the night, probably about 11 or 12 P. M., told me this morning that it was more brilliant at

that time than earlier in the evening. An old Californian who saw it, said it was the first time he had ever witnessed any thing of the kind.

"The transit of Mercury on the morning of the 9th I was designing to observe as well as I could with the telescope of my theodolite; but the weather proved to be densely foggy where I then was. The August meteors I lost from the same cause.

"There are portions of California where the sky is most admirably adapted to astronomical observations, being almost perfectly cloudless for eight months of the year in succession, and generally unclouded a large portion of the remaining four. Beautiful sites for an observatory might be selected in the neighborhood of *Puebla de San Josè*, fifty miles south of this place."

4. *Gold Mining in Virginia*, (Mining Journal, London, April 15, 1848.)—As every thing connected with the successful results of mining operations, particularly as regards the precious metals, is of the most lively interest, we proceed to lay before our readers some account of a gold mine in the state of Virginia, in North America, supposed to be the most extensively worked, and the best organized of any of the gold mines in the United States. This mine is situate in a fertile and populous country, with good roads, and rapid and easy conveyance, and when we consider the mining districts of South America and Russia, their almost inaccessible situation, difficulty and expense of carriage, &c., the superiority of the situation of those of North America is self-evident.

"The Orange Grove or Vaucluse Mine is situated in Orange County, State of Virginia, near the eastern line of Spotsylvania County, about two miles north of the Swift-run gap turnpike, leading from Fredericksburg to Orange Court-house, one mile south of the Rapidan, or south branch of the Rappahannock River, and about seventeen miles from Fredericksburg This mine was discovered in 1832, and for a number of years worked as a deposit or surface mine for gold, before the veins or lodes of ore containing the precious metal were discovered. The surface working, or washing, for gold on the estate has been conducted from that time (with few, if any intervals) until the year 1846, always yielding a good profit for the labor and capital employed. The veins or lodes of ore, which are numerous, run N.N.E. and S.S.W., and dip to the N.E. The walls of the same are of various slates. The ores are slate, talcose, schist, and quartz, containing sulphuret of iron, brown oxyd of iron, black and brown hydrates of iron, and the slates near the veins or lodes are highly metalliferous and often colored with iron. At the depth of seventy or eighty feet, the hydrates are often found incrusting the sulphurets, all of which contain gold, and some of which are very rich. The lodes, or veins, vary in size and width, from four to twenty feet, and some bodies of ore are found as wide as thirty or forty feet; most, if not all, are connected, one with the other, by small leaders, or threads. Parallel with these, there has been discovered ore containing native copper in minute crystals, and also the sulphurets and oxyds of copper and iron, all rich in gold, but they have not been worked to any extent, as the native copper forms an amalgam with the gold and quicksilver, which requires the process of cupellation to separate the gold. All the ores here are worked by

amalgamation; there is, however, not the least doubt, but that they can and will be worked to great profit, when the process of smelting is introduced, which is now about to be done, whereby the rich sulphurets and hydrates which are now laid aside, can be advantageously worked. This would add materially to the returns of gold, as agreeably to experiments made on a very large scale, by order and at the expense of the Russian government, it resulted, that a given quantity of ore, which, by the ordinary washing process yielded five-sixths of an ounce, produced by the smelting process no less than seventy-two ounces and five-sixths of an ounce, thus showing, that by this means there was obtained no less than eighty-seven times more than by the old method. In 1844, the present establishment was commenced, the mine purchased, and a powerful and very superior English condensing engine brought on the ground for the purpose. It will be recollected, that the former proprietor commenced operations without the least capital, and had purchased the mine, erected all the machinery and buildings, and built one of the largest, and one of the most complete establishments for mining purposes in the United States, and all from the products of the mine. The mineral tract contains two hundred acres, lying in a long and comparatively narrow strip on the course of the veins, so as to give to each vein a line of dips in length of one and a quarter mile from N.N.E. to S.S.W. There is likewise attached to the same estate, beside the wood on the mineral land, one hundred and fifty acres of wood and timber land for the engine's consumption, or fire-wood. The location is one of the healthiest in Virginia, and its proximity to Fredericksburg and the northern counties makes it one of the most desirable mining properties in this country. The machinery consists of a very perfect condensing Cornish mining-engine, one hundred and twenty horse power, over which is a first rate substantial engine-house, and stack fifty feet high. On the north of the engine and boiler-house is a large frame mill-house, containing six large Chilian mills, consisting of cast iron bed plate, five feet and six inches, and weighing 2200 pounds each. On each of the six bed-plates are two runners, or cast iron wheels, or twelve in number, five feet and six inches, eleven inches face, and two inches thick, running on the edge, the centres of which are filled with heavy oak timber, and each, with their shafts, weighs about 2000 pounds. These mills are situated in two rows, and are geared to, or receive their motion from, the steam engine. As all the ores are ground in water, each mill is supplied with warm and cold water at pleasure; twelve inches from the top of the bed-plate there is a wide open mouth which allows the turbid or thick water (caused by the grinding or reducing the ores) to escape into a trough, by which it is conducted to the tanks or reservoirs. There is likewise in this department the machine for washing the residuum, and obtaining the amalgam and quicksilver hereafter mentioned. On the south side of the steam engine is the stamp-house and amalgamating room, containing six batteries of three stamps each, or eighteen in number, also driven by the engine, and each of which, with the iron head of 125 pounds, weighs 350 to 380 pounds. The stamps of each battery of three are supplied with water, which is regulated by a stop-cock; at each blow of the stamp a portion of fine ore, freed gold and water, pass out of

the boxes through the grates, and thence through troughs to the amalgamating rooms. The bowls are supplied with runners, which move horizontally; in the center of these runners is an eye or opening, like that in the runner of a corn mill. The ground, or fine-stamped ore, gold, and water pass into this eye or center, and by the rotary motion of the same, are brought into contact with the quicksilver deposited in the center, and form an amalgam, the affinity of the one for the other being very great. To the east, and near the eighteen amalgamating mills, are three dolly-tubs, or catch-alls, about five feet in diameter, into which the ore, &c., after passing through the amalgamators run, depositing any quicksilver or gold that may have passed off, should the machinery of the former not work as it ought. After this the whole mass passes to the strakes, or inclined planes, where the sulphurets, &c., are deposited, and the earthy matter washed away. On the south of the stamp or amalgamating house, there were formerly two heavy Mexican drags, or *arastres*, for the reduction of sands and sulphurets; but, not answering so good a purpose, they have been altered into three heavy Chilian mills, like the six described in the north wing, but rather heavier. Besides the buildings for the machinery, which are all of substantial frame, there are dwelling houses for agents, superintendents, boarding houses, carpenter's shop, store-house, blacksmith and machine shop, grist-mill, cabin for one hundred to one hundred and fifty workmen, stabling for twenty horses, and all necessary out buildings, as bake house, kitchen, &c. The buildings are all in good order and new. The ore is raised from the pits, or shafts, which vary from thirty to eighty feet deep, by hand windlasses and horse-whims, in iron bound buckets, to which are attached well tried iron chains, imported for the purpose, instead of ropes. The ores, on arriving at the surface, are divided into but two classes—coarse and hard ore for the stamps, slate and fine or small ore for the Chilian mills; this is done by means of a large screen. The ore which passes through this screen is sent in carts, or by railroad, to the mill-house, and the coarse, or large pieces, to the stamps; the very large pieces are first broken with hammers, but this is seldom required. The water is raised from the different shafts or pits, as it accumulates in the mines, and runs from thence to the dam, or great reservoir, where all the water from the various branches, as well as the pits, is concentrated, and passes through a tunnel to the large well-room, in which are located one seven-inch and one four-inch lift or pump, to raise the water into a large cistern, containing 7000 gallons, for the steam-engine, mills, stamps, and all other purposes required in the working and washing processes. Attached to the steam-engine by a connecting-rod or joint, and raised on a heavy frame-work above the working beam of the same, is a large balance-bob made of heavy oak timber, the out end of which works outside the engine-house. There is connected or attached a large sliding-rod, passing down into the pit or well-room; to this is connected by offsetts the two lifts or pumps as above mentioned, and likewise another or second bob, connected at pleasure, which drives the line of flat-rods, leading to the different pits, where they are connected by the different bobs, to the lifts or pumps in the shafts, from which the water is raised to the surface.

"The small or fine ores are ground in the Chilian mills in water, which, as before stated, constantly passes off, carrying the finely ground ore and earthy matter with it; the gold, being freed from the matrix or ore, is carried or precipitated to the bottom by its specific gravity. One boy attends three mills a term of twelve hours; at the end of every twelve hours the mills are cleaned out, taking all the residuum of the ore, which has been ground during the term, and which in each mill is reduced to about three common buckets full, in which are the gold and quicksilver, having formed an amalgam; the gold which has been freed falls to the bottom or bed-plates, comes in contact with the quicksilver, for which it has a very strong affinity; this residuum is placed in a strong iron-bound box, sufficiently large to hold the contents of all the mills for the twelve hours, and at the end of every twenty-four hours, or two terms, is washed out, or rocked down in a machine for the purpose, where the gold amalgamates, and the amalgam of gold and quicksilver is obtained and washed clean, which is then strained through buckskin or fine Nankeen, expressing all the superfluous mercury, and leaving the amalgam of gold and quicksilver dry, and in a hard ball. The same process is pursued with the residuum from the stamps, or amalgamators; these balls are then placed, in sufficient quantities, in an iron retort, well luted, the lid or top secured by a strong iron band and thumb-screw; the retort is then placed in a small iron pot or furnace, the mouth of the same being inserted in water. When the temperature of the furnace is raised from 660° Fah., the mercury or quicksilver escapes in vapor, and is condensed in a metallic form in coming in contact with the water; after a short time, say thirty or forty minutes, according to the mass and heat applied, the process is complete—and, on opening the retort, the gold is found, if clean, of a bright yellow color, but porous or spongy; it is then placed in a crucible, and melted with a little borax or potash, and, if impure, a little nitre or saltpetre, is added. When completely fused, it is cast into an ingot, and the work is complete, bringing out a beautiful bar which usually weighs, when full, about 1000 dwts., and of a fineness of ·985 or ·990 fine, or nearly nine per cent. finer than the coin of the United States. The quantity of quicksilver used, and the annual loss in this large establishment, is not over from two hundred and fifty to three hundred pounds, at a cost of $1 20 to $1 50. The quantity of ore ground per day varies according to its quality or character, as hard or soft, quartz or slate, sulphuret or decomposed ores. The machinery is now sufficient to reduce a great quantity, and the engine, which is powerful, is capable of driving much more; the engine cost $10,000 to import from England. The whole establishment is built with a view to permanency and usefulness; the quantity of ore is, without doubt, inexhaustible; the ore varies somewhat in richness, but has always paid a great profit, as the whole establishment, machinery, buildings, also tools, horses, wagons, and carts, fall little short of the cost of $70,000, and have all been procured by the proceeds of the mines, as well as the purchase money of the property. Pieces weighing two, three, and four dwts. (the dwt. of gold from this mine is worth from 98 to 100 c.) have been taken out as deep as from thirty to sixty feet, and from three to four pounds of the ore as much as sixteen to eighteen dwts. have been obtained by pounding and washing."

This description is fully supported by the report of Mr. O. Matthews, mining engineer, and that of a committee of three gentlemen, appointed expressly for an official inspection of the mine, in September, 1847; as also from an analysis by Mr. J. C. Booth, of Philadelphia, of four specimens, producing respectively, 16 dwts. 4 grs., 12 dwts. 12 grs., 6 dwts. 13 grs., and 2 dwts. 12 grs., to the one hundred pounds of ore—who states they would produce three times as much if they could be obtained free from matrix, and that either would yield a rich matt by smelting. The direction of the Orange Grove Mining establishment is, with the exception of two gentlemen, we believe, entirely under the control of British subjects.

5. *On Common Salt as a Poison to Plants;* by W. B. Randall, (Proc. Brit. Assoc., Athen., No. 1086.)—The following notice is presented as being likely to afford a useful practical caution to those interested in the cultivation of plants. In the month of September last, three or four small plants in pots were shown to the writer nearly or quite dead; and he was, at the same time, informed that their destruction was a complete mystery to the party to whom they belonged, and that Dr. Lindley had expressed his opinion from the examination of a portion of one sent to him, that they were poisoned. Having searched in vain for any strong poison in the soil, and in the plants themselves, he inquired more minutely into the circumstances of the case, and found that these were only specimens of many hundreds of plants both in the open air and in the green-houses (but all in pots) which exhibited, in a greater or less degree, the same characteristics. The roots were completely rotten, so as to be easily crumbled between the fingers; the stems, even in young plants, assumed the appearance of old wood; the leaves became brown, first at the point, then round at the edge, and afterwards all over; while the whole plant drooped and died. At least two thousand cuttings in various stages of progress, and one thousand strong, healthy plants had been reduced to this condition; including different varieties of the fir, cedar, geranium, fuchsia, rose, jasmine, and heath. The sight of this wholesale destruction, coupled with the fact that the whole were daily watered from one particular source, suggested the conclusion that the cause of the evil must reside in the water thus used; and this was accordingly examined. It yielded the following constituents, making in each imperial pint of twenty fluid ounces, nearly 9½ grains of solid matter entirely saline, without any organic mixture:

Carbonate of lime, ...	0·600
Sulphate of lime, ...	0·462
Chlorid of calcium, ...	0·200
Chlorid of magnesium, ...	1·252
Chlorid of sodium, ...	6·906
	9·420

The mould around the plants and an infusion of the dead stems and leaves also afforded abundant evidence of the presence of much chlorid of sodium. Farther inquiry showed that the well from which the water was procured had an accidental communication by means of a drain, with the sea; and had thus become mixed with the salt water from that source, and had been used in this state for some weeks, prob-

ably from two to three months. From about that time the plants had been observed to droop; but it was not until nearly the whole of a valuable stock had been destroyed, that any extraordinary cause of the evil was suspected. To place it beyond doubt that the water was really the cause of the mischief, twelve healthy fuchsias were procured from a distance and divided into two parts; half being watered morning and evening with the water in question, and the others with rain water. In a week the six plants watered from the well had turned brown, and ultimately died, while all the rest remained perfectly flourishing. Assuming, from these facts, that the common salt in this water was the chief cause of the results described, it is proved that water containing about seven grains of salt in each pint is, in its continued use, an effectual poison to the weaker forms of vegetation; or that when a soil is continually watered with a weak solution of salt, it gradually accumulates in it until the soil becomes sufficiently contaminated to be unfit to support vegetable life. In either case an interesting subject of inquiry is suggested—What is the weakest solution of salt which can produce in any measure this poisonous effect?—or, in other words, at what degree of dilution does the danger cease? For salt is an important natural constituent of much spring water, quite independent of any infiltration from the sea, as in this instance. Thus:—the water of the artesian well, Trafalgar Square, London, contains in each gallon about 20 grains; that at Combe & Delafield's Brewery 12·7; that at Wolverhampton Railway Station 6; one lately sunk at Southampton, for supplying a private manufactory, 40. May it not be asked, whether the subject of the suitableness of waters in general for the various purposes to which they are applied—be it in manufactures or for steam-engines, domestic purposes or for drinking—is not worthy of a greater share of scientific attention than it has hitherto commanded?

6. *On the Influence of Temperature upon the Distribution of Fauna in the Ægean Sea;* by Lieut. Spratt, (Proc. Brit. Assoc., Athen., No. 1088.)—After the publication by the British Association of the highly interesting Report of the Distribution of the Fauna of the Ægean by Prof. Forbes, I was led to imagine that temperature might have a great influence on that distribution. With this view I pursued the inquiry by making observations on the temperature of each region as opportunities offered for so doing, whilst employed on the survey of the Ægean Sea during the summer seasons. These results show distinctly that temperature seems to be the principal influence which governs the distribution of the marine Fauna. The summer temperature of the air in the Mediterranean is about 86°, and the surface temperature reaches nearly that temperature generally at that season. The zones of depth as arranged by Prof. Forbes are as follows. The first region includes all between the surface and the depth of two fathoms; but this he subdivides into a superficial or tidal zone of about two feet: the inhabitants of which, he observes, are remarkable as being such as have a wide range in depth, eight out of eleven species peculiar to it being widely distributed in the Atlantic. The temperature of this zone ranges from 76° to 84° during eight months in the year. Its inhabitants are consequently subject to great vicissitudes of climate during the summer and winter. Nature having thus adapted them to these con-

ditions, we consequently find that they are wanderers through great geographic space, corresponding to the vicissitudes of temperature to which they are subject. The second region reaches to the depth of ten fathoms, in which, with the last subdivision of the first region, we have, says Prof. Forbes, the characteristic Fauna of the Mediterranean. Now the temperature in this region is seldom lower than 74° in the long summer season, and it is consequently the region upon which the Mediterranean temperature has a more permanent influence, for which reason we find in it the peculiar Mediterranean Fauna. The third region descends to twenty fathoms and has a decreased temperature to 68°. In the fourth region it is 62° at the depth of 35 fathoms. In the sixth region the temperature is 56° at the depth of seventy-five fathoms; and in the seventh and eighth regions, to the depth of three hundred fathoms, the temperature decreases only to 55° or 55½°, as far as I was able to ascertain. Thus, between the littoral zone and the lowest region there is a difference during summer of 26°, and sometimes to 30°; and between the second region (the Mediterranean) and the lowest, the temperature is about 20°; thus standing at the average temperature of a high northern latitude. After limiting the Mediterranean Fauna to the second region, Prof. Forbes remarks, that the third is a transition zone; but in the fourth region the Celtic character of the Fauna is remarkable, there being in that region nearly 50 per cent. of species identical with northern forms. In the sixth and lower regions he remarks that although the identical Celtic species were fewer in the lower region, "he found the representation of northern species so great as to give a much more boreal or subboreal character than is present in those regions where identical forms are more abundant." Amongst the Ægean Fauna are some which have a wide range in depth,—there being nine species common to six regions, seventeen to five regions, and two common to all,—more than one half of which are *known* to be wide geographic rangers. They, like the cosmopolite species of the littoral tidal zone, being thus adapted to climatal changes, become consequently ramblers over wide geographic space, as they ramble into representations of climate in regions of depth. Thus, we have the climate of a parallel represented in marine depths as in terrestrial elevation;—and thus it appears that density in depth is not so great an antagonist to the existence of animal life as is generally supposed. The greatest depth at which I have procured animal life is from three hundred and ninety fathoms; but I believe that it exists much lower, although the general character of the Ægean is to limit to three hundred fathoms; but as in the deserts we have an oasis, so in the great depths of 300, 400, and perhaps 500 fathoms, we may have an oasis of animal life amidst the barren fields of yellow clay, dependent upon favorable, and perhaps accidental, conditions,—such as the growth of millepore, now found to be a vegetable instead of a coral,—thus presenting prolific spots favorable for the existence and growth of animal life. These peculiar conditions of density and food develop necessarily a peculiar Fauna, upon which climatal influence, nevertheless, stamps its characteristic forms throughout the species.

Dr. Williams inquired whether the temperature of the water was not different from the temperature of the earth or mud on which it rested

—a point which he believed of material importance. Mr. J. Ball inquired of Prof. E. Forbes how far Lieut. Spratt's researches confirmed his views of the nature of the deep-sea Fauna of the Ægean? Such inquiries as those engaged in by Lieut. Spratt were of great importance for the purpose of ascertaining how far temperature and other causes might interfere with the distribution of animals according to Prof. Forbes's law. He would suggest whether deep-sea observations on temperature might not be carried on better with thermometers dependent on the expansion of solid metals. Prof. E. Forbes expressed his obligations to Lieut. Spratt for the able manner in which he had carried on these researches; they were of great value and interest. In answer to Mr. Ball, he stated that these researches quite confirmed the correctness of the views he had taken with regard to the distribution of animals and plants; and the further researches made by the dredge since the time he had first announced them at Cambridge, had also done so. Dr. T. Williams performed some experiments with an air-pump, from which he inferred that the influence of the pressure of the atmosphere had been very much overlooked in accounting for the distribution of animals in the air and sea. He had also performed some experiments on the distribution of light, which led him to conclude that this agent was much less influential when passing through water than is generally supposed. Sir E. Belcher could generally confirm the correctness of Lieut. Spratt's measurements of temperature. In taking the temperature of the deep-sea he had used an instrument which he described, and which prevented any accident to the thermometer. He had always found the mud or bottom of the sea of the same temperature as the water directly above it. Fish lived at much lower depths than Dr. Williams had supposed possible. He had seen them brought up from a depth of one hundred and fifty fathoms. The bottoms of vessels were examined with great facility by means of tubes, and in clear water the sea bottom had been seen at a depth of thirty-three fathoms. He alluded to the great difference of temperature produced by currents in the sea. Thus, the gulf-stream often exhibited a temperature of 86° whilst the surrounding ocean was not more than 60°. Prof. E. Forbes stated that animals brought up from a depth of two hundred and seventy fathoms lived very well in water on the deck of a vessel—thus showing that pressure had little to do with their existence. The inference, that light penetrated to great depths in the ocean, was founded on the existence of color in plants at those great depths. As a proof that the influence of temperature was very great, he might state that an entirely different Fauna and Flora existed in the gulf-stream from that which existed on its borders. Mr. J. Ball believed that adaptation to pressure was speedily effected in animals. No proper inference could be drawn from Dr. Williams's experiments on light through tubes. The light in water was diffused, and not in tubes. Dr. Carpenter stated that animals differed in their power of bearing pressure. The condor, in descending from its flight, frequently passed through three miles of atmosphere in a few moments. The whale was said to go from the surface to the depth of one thousand fathoms. Man, although at first affected by the rarefied air of a mountain, soon became used to it.

7. *On the Advantageous Use made of the Gaseous Escape from the Blast Furnaces of Ystalyfera;* by Mr. J. Palmer Budd, (Proc. Brit. Assoc., Athen., No. 1086.)—This communication drew attention to an economical application of the heated gases which are usually allowed to escape from the top of the iron furnaces. It appears that the gases which are evolved from these furnaces escape at a temperature which is about the melting point of brass. In the iron works at Ystalyfera, where the iron is smelted by the use of anthracite coal, advantage has been taken of this in a most ingenious manner. By an arrangement, which is in its character exceedingly simple, but somewhat difficult to describe without a model (Mr. Budd's description was illustrated by a very nicely constructed one), the hot gas is led off into another channel by means of a strong current generated through a chamber and air-way from a point just below the top of the iron furnace. It is conducted, very little heat being lost in the passage, under the boiler of a steam-engine; and it is found to be at a sufficiently high temperature to heat the boiler without the consumption of any fuel whatever. Hence an immense saving is effected. Although only one furnace and one boiler has hitherto been adapted to this purpose, it is found to effect a saving of 350*l.* a year. We may consequently expect that when the experiment is further extended and more of the furnaces so arranged that this heat may be economized and employed for the numerous useful purposes to which it is applicable in a large establishment, the saving will amount to many thousands annually. This communication is to be printed entire in the Transactions.

8. *Lawrence Scientific School at Cambridge.*—The programme for the second term of the year 1848–49, from March 1st to July 14th, contains the following announcements:—1. Instruction in analysis and other departments of Chemistry, by Prof. Horsford, during the course of the term, together with lectures from the 2d of April.—2. A course of twenty-five lectures with private instruction on Zoology by Prof. Agassiz. Excursions will be made with those who intend to make a further study of the Sciences.—3. A course of twenty lectures by Prof. J. Wyman on Anatomy and Physiology, with instructions in the use of the Microscope.—4. Lectures on Botany by Prof. Gray through the term, twice a week, commencing with Monday, the 5th of March.—5. Lectures on Mineralogy and Geology by Prof. Webster.—6. Lectures on Experimental Philosophy, by Prof. Lovering.—7. Lectures on Mathematics by Prof. Peirce, from the 1st of March to the middle of June.—8. Instruction in the use of astronomical instruments at the Observatory, by W. C. & G. I. Bond.

The fees for the Chemical course of lectures, *ten dollars;* for the others, *five dollars;* for special instruction in the Chemical laboratory for twenty weeks, including apparatus and supplies, $75; for three days per week, $50; for one day, $25. The special students supply themselves with flasks, retorts, crucibles and other apparatus consumed in using, besides lamps, alcohol, gold and silver solutions.—For private pupils in other departments, not exceeding the rate of $50 per term of twenty weeks.

9. *Daguerrotypes of a Chimpanzee, a species of Orang Otang.*—M. Geoffry Saint Hilaire, presented to the French Academy in October

last, a daguerrotype likeness of a Chimpanzee belonging to the menagerie of the Museum of Natural History, and remarked upon the importance of this method of taking designs of animals.

10. *Climate of Italy.*—M. Dureau de la Malle closes an elaborate investigation into the climate of ancient and modern Italy, with the conclusion that the limits for different agricultural products were the same in the earlier as in more recent periods, and that from the time of Augustus till the present, there has been no sensible modification of temperature either as regards the months or years.

11. *Goitre due to Magnesian Salts in water.*—The waters of the valley of Isère, have been chemically and geologically examined by M. Grange, with the conclusion that the goitre or cretinism of Switzerland, is due to the deleterious action of magnesian salts in these waters, or perhaps at times to the presence of magnesia and the absence of the lime required by the animal economy. The author suggests as a remedy, the filtration of water in large reservoirs filled with carbonate of lime and a thin bed of lime.

12. *Motive Power*, (Athenæum, No. 1106.)—M. T. de Beauvegard has constructed a steam-engine to be moved by the vapor of water in the spheroidal state, the elastic force of which being very great; and an experiment is in progress in London on a large scale. The same principle was made use of by Mr. J. C. C. Ruddatz, in 1825, and a patent got out: and subsequently, Mr. Thomas Howard constructed an engine in which water was projected in small quantities upon a plate of iron resting on hot mercury. But these earlier projects were not successful.

In Whitechapel, at Messrs. Horne's, there is an engine worked by the combined influence of steam and chloroform. The steam after doing its work in moving the piston in one cylinder, escapes into another in which there is a quantity of chloroform in small flat tubes. This substance volatilizes at a very low temperature; it is thus converted into vapor by the heat of the waste steam, and in this state is employed to work a second piston. There are, indeed, two engines combined in action, one moved by steam, the other by chloroform. The proposed advantages are the saving of 50 per cent. of fuel. The first engine of this kind was constructed in 1846 in Paris, in which ether was employed, and this engine is still working in a glass factory at Lyons, chloroform being substituted. A Parisian paper states that a powerful and efficient engine of this description has been constructed by M. Charles Beslay, by order of the Minister of Marine. The English patentees propose to use a volatile fluid which is much less expensive than chloroform, equally efficient and less obnoxious.

13. *Coal in the Straits of Magellan.*—There has been a recent announcement of the discovery of coal in the Magellan Straits; if abundant and of good quality, it will prove of great importance to steam navigation. Samples of the coal have been transmitted to the English Board of Admiralty for scientific examination.

14. *Gun Cotton for tooth ache.*—Gun cotton dissolved in ether, constituting what is called collodion, has become an important material for dressing incised wounds. It has been also ascertained that it may be successfully used for the tooth ache. The cavity of the tooth being cleaned out, a little asbestus saturated with collodion, to which a little

morphia is added, is placed in it. All soon becomes solid; and thus an excellent stopping and a powerful anodyne are applied at the same time.

15. *Native Silver in Norway.*—It is reported in the Swedish official paper of the 27th of October, that at the King's mine, at Konigsberg, two lumps of native silver, severally 238 and 436 pounds, were obtained within the preceding two months. This mine was offered for sale in London twenty years ago for £10,000, but failed of purchasers. It now brings to the government more than this sum annually.

16. *Naphtha Spring near Alfreton, England.*—A valuable spring of mineral oil has made its appearance near Alfreton, in a coal pit. The oil has a dark tarry color; but on distillation it affords a volatile liquid which has been found to be a good substitute for chloroform as an agent for acting on the nerves of sensation, besides a colorless inflammable oil, excellent for lamps, and solid paraffine.

17. *Prizes.*—The Belgian government has instituted two prizes, one of five thousand francs with a gold medal, and the other of one thousand francs—the first for the best work on agriculture, and the second for the best treatise on the potatoe-disease. Foreigners are invited to compete; manuscripts are to be sent to the Ministry of the Interior before the 1st of January, 1850.

18. *Chloroform, as a solvent.*—Chloroform dissolves abundantly the various fatty and resinous substances, and generally all highly carbonized compounds. With copal it forms readily a good limpid varnish. It is now known to dissolve caoutchouc, and leaves it with its original properties, on evaporation.

Appendix.—*Observations on California, from the correspondence of the* Rev. C. S. Lyman.—(Continued from page 292.)

The letters from which the following extracts are made, were put into our hands at a late hour. They are not as recent in date as some that have been published in the public papers within the fortnight past: but our acquaintance with Mr. Lyman enables us to vouch for their literal accuracy, and this may give them value in the estimation of our readers. He left the country for his health, and after a residence for a while at the Sandwich Islands, went to California, hoping to be benefitted by the climate, and at the same time to engage in surveying. He had been occupying himself in this pursuit for about nine months, when the discovery of gold carried off his chain-men, "who exchanged $25 a month for as much a day," and he was compelled thereby to suspend his surveying labors.

Gold Mines on the American Fork of the River Sacramento,
Upper California, August 6th, 1848.

Finding I could do nothing at surveying, and wishing to examine the gold region, I started thither early in June and was two weeks getting here, on account of the flooding of the river San Joaquin. I had little or no expectations of obtaining gold myself, as I supposed the reports of the richness of the mines altogether exaggerated. But when I reached the ground I found the half had not been told. A company

of five of us made trial of digging the gold on the bank of the Rio de los Americanos, forty miles east of Sutter's, (New Helvetia). We rigged a rude machine in a day for washing the earth, and dug and washed the earth from the river's bank eight days, when we found on weighing, that we had obtained about $350 worth of gold apiece, or 44 dollars a day. The last day's work gave us over 70 dollars, but as we heard others were doing much better ten or twelve miles up, we quitted such *poor* wages, and moved camp for the other place. This was six or eight miles from the river, and in ravines which are dry in summer. Here two of us in company, dug in five days a little over $1000, or over $100 per day apiece, which we thought pretty fair wages. Since that, our success has been various, ranging from $10 to $50, or $80 per day. Others have done much better: able-bodied, hard working men, who happen to have good luck in hitting on a rich place, often get from 100 to 500 or more dollars a day; others have obtained comparatively little.

It is on the whole a precarious business, though almost none that work at all can fail of making from five to fifteen dollars per day. It resembles more than any thing else, a lottery with many large prizes, innumerable middling and small ones, but almost no blanks. My success has probably been not far from the average. A large part of the population of California is assembled here, and probably from two thousand to three thousand people are digging. From 1,000,000, to 2,000,000 or 3,000,000 of dollars have doubtless already been taken from these mines, and the productiveness of them seems almost inexhaustible.

The gold region is as extensive as the whole State of Connecticut. In almost all parts of it in the creeks and ravines, and even on the hills, gold is to be found in considerable quantities. That obtained on the main river is generally in fine grains or scales, averaging the size of flaxseed. This is the kind I obtained when I first came. It occurs in the river alluvium and may be washed out at the rate of about forty or fifty dollars worth from a cart load of earth. In the ravines higher up the river, the gold is larger. Where I got the five hundred in five days it occurred in a gully or ravine dry at this season, and generally within a foot of the surface. Mr. D. and myself dug out the $1000 in the space of about a rod in length, making a ditch of about two feet wide and one deep. While digging we picked up nearly three hundred dollars worth in little lumps visible to the eye. The gold was in little irregular masses, from fine grains to the size of peas or raisins, and occasionally lumps weighing from one to two ounces and as large as walnuts. Under the earth in which the gold is deposited, is a bed of argillite or clay-slate with the edges of the laminæ standing nearly perpendicularly, and presenting a very irregular surface, with abundant little pockets for retaining the gold, which is found most plentifully on its surface and in its crevices. In all this region for many miles around, where the gold is dug from the ravines, the underlying rock is some form of this slate, and uniformly presents a dip approaching to perpendicular. On the river the gold stratum rested on *hard pan* or a stratum of coarse granitic sand. The gold is uniformly associated with quartz which is very abundant, and often lumps of gold occur with quartz imbedded, and I have seen pieces moulded on regular quartz crystals.

Two weeks ago I made an excursion into the Snowy Mountains forty-five miles higher up the river. Twenty miles above this, the quartz nearly ceases, and the gold also so far as we could discover; and we passed first a region of gneiss, and afterwards of granite which forms the backbone rock of the Sierra Nevada, or Snowy Mountains. We ascended perhaps eight thousand feet, and approached within eight or ten miles of the snow, though in the middle of July. The range before us in its white robes presented a beautiful appearance.

Gold occurs also in abundance on the Sacramento, the Feather and Uba rivers, Bear Creek, the river Cosumnes, and in short over a region fifty miles wide by a hundred in length—and how much farther I know not.

The discovery of these rich mines may prove beneficial to the States, but it will be a curse to the general prosperity of California. Agriculture, and the arts will be at a stand still;—a few merchants will make fortunes.

In a moral and social point of view, California was bad enough before, but the gold mines will make the matter ten times worse. At the mines, the population is like a nest of ants running hither and thither. Law cannot well be made to exert its power—vice is unrestrained;—hundreds of runaway sailors and soldiers are here, and with their little fortunes dug out in a trice, will have frolicking and drunkenness to their heart's content.

Goods sell at enormous prices. Checked shirts sell to the Indians for fifteen to thirty dollars. Glass beads for their weight in gold. I gave ten dollars for a poor shovel, and ten more for a pick. Flour is from thirty to forty cents a pound,—coffee one dollar,—figs and raisins one dollar,—salt one dollar a quart,—sugar fifty cents to one dollar a pound,—beef from twelve and a half cents to twenty-five cents per pound,—shoes ten dollars per pair,—thin pants eight to ten dollars,—ardent spirits six dollars per bottle, and other things in proportion.

Pueblo de San Josè, Nov. 6th, 1848.

I left the "diggings" the last of August to avoid the sickness which it was expected would prevail, and which indeed was quite prevalent for several weeks, especially in the vicinity of the Sacramento river. It was chiefly billious and intermittent fever. After spending a month here and at San Francisco, I made a trip to another part of the mines on the river Stanislaus, one hundred and forty miles from this place, and one hundred or more from the diggings where I wrote the letter referred to above. I returned a few days since, having been absent a month. While at the mines, although many of the miners had left, flour was sold at $1.50 per pound, and brown sugar at $3.00. Flour had been sold two weeks earlier from 2 to 4 dollars, and sugar $4.00. These are fair specimens of the prices at the mines. Poor tallow candles bring fifty cents apiece—sperm $1.00 do.—Onions $1.00 a pound—bullocks $100 a piece, and other things in proportion. But the most profitable article of traffic is *liquor*, which of course no man of any principle will have any thing to do with. But while I was at the Stanislaus a fellow opened a grog booth there and cleared over $7,000 in *six* days, and that from two barrels of liquor.

The diggings on the Stanislaus, and several other tributaries of the San Joaquin, have been discovered and opened within the last two months, and many hundreds of thousands if not millions of dollars dug out. Some instances have occurred of individuals obtaining from fifteen to twenty-five pounds of gold in a single day, i. e., from 3,000 to 5,000 dollars. One lump of pure gold was found weighing eighteen pounds avoirdupois. This I have not seen, but am credibly informed of the fact. It was found by Lorenzo Trugillo, a New-Mexican, and I presume he has taken it home with him.

I am told that in one or two places gold has been found *in place*, in veins or beds of quartz interposed among other rocks. But to this fact I cannot vouch, as I have not seen any such myself. Dikes or beds of quartz rock many feet in thickness, and often of great length, are numerous, and generally among nearly perpendicular strata of some form of slate or gneiss rock. All the gold thus far discovered occurs uniformly, so far as I have observed, in one geological formation and no other—i. e., the drift or diluvium, a bed of pebbles and gravel of various sizes lying next beneath the soil, and resting, unconformably, on the rocks beneath—which in most of the diggings are some form of slate or gneiss, running about N.N.W. and S.S.E., and dipping nearly perpendicularly. Like the pebbles of the drift, the gold is uniformly water-worn, and unquestionably was deposited in its present position at the same time and by the same agency as the stratum in which it occurs. It is surprising how little accurate information respecting the region exists even among the thousands of people—many of them intelligent men—at present on the ground. The general impression is that the gold has been thrown from volcanoes in a melted state—numerous places are confidently described as the craters of extinct volcanoes; whereas the entire region is just about as volcanic as the state of Connecticut and no more. The craters spoken of are some of them in a region of *sandstone!* and others among some magnificent ranges of trap or basalt, where from the mural and blackened aspect of the ridges, often arranged in forms somewhat circular, such a mistake is not to be wondered at in persons ignorant of geological phenomena.

The extent of the known gold region is daily augmenting—rich explorations now spreading over a district some four hundred miles in length by thirty or forty at least in width, in almost every part of which gold is to be found in abundance. Probably over $6,000,000 have already been extracted, and next spring the digging will be carried on with redoubled energy. Many have already made handsome fortunes, chiefly those who have had facilities for trading, or had a train of Indians digging for them, or been so lucky as to stumble on a deposit containing its pounds of metal—neither of which three circumstances has happened to me. I have now resumed my former business of surveying, and design to follow it so long as the weather will permit.

It is now nearly time for the winter's rains to set in, but as yet the weather continues delightful. I like surveying much better than gold digging—chiefly because it furnishes some occupation for the mind as well as the body. Living is very expensive here at present, and will continue to be so—the price of labor, provisions and every thing else being proportioned to the abundance of gold. Business is brisk—stran-

gers are flocking in from the Islands, Oregon and elsewhere, and in the spring I suppose there will be a rush from the States.

There is at present little or no government here—society is in an unsettled state—and yet general order prevails to a remarkable degree—a fact which excites surprise even here, and speaks volumes in favor of the American character. As a race our people are lovers of order, and when put in circumstances where there is really no government, their habits of self-government are such that every thing goes on pretty much as it would in any of the old and well governed States. Notwithstanding the thousands of all classes and all countries collected at the mines, back in the wild mountains, without an officer of justice within a hundred miles, and with abundance of rum and gambling, scarcely an instance of serious disturbance has taken place—a shocking murder, committed by a drunken man a few weeks ago, being the first occurrence of the kind that has been known. But in the present state of things—education and moral training being almost wholly neglected, and the country fast filling up with the desperadoes and offscouring of all lands, this state of comparative quiet cannot be expected long to continue. The day of robberies, and outrage, cannot be far distant, and a state of society I fear will prevail that will be anything but desirable.

VI. Bibliography.

1. *Alph. De Candolle, Prodromus Reg. Veg.: pars XII, Sistens Labiatas et quinque minores Corolliflorarum ordines.* Paris: 5r. Nov., pp. 707.—The twelfth volume of the Prodromus, delayed somewhat by the convulsions of the Continent, will be welcome to botanists. It concludes the series of Monopetalæ, with the exception of the small family Plantaginaceæ, and the large one of Solanaceæ, which last, Prof. Dunal—from whom it has long been due—appears to find by no means easy to elaborate. Of the present volume, all but one hundred pages are occupied by the *Labiatæ*, from the hand of the most unwearied and best of monographers, Mr. Bentham. The plants of this large order, arranged in one hundred and one genera, are thrown into eight tribes, instead of the eleven in the *Labiatarum Genera et Species;* the Satureieæ now being made to comprehend the Menthoideæ and the Melissineæ of the earlier work, and the Scutellarineæ being merged in the Stachydeæ. The *Ocimoideæ*, comprising nineteen genera, are represented in extra-tropical North America solely by one or two species of Hyptis, which inhabit our southeastern frontiers.

Of the *Satureieæ* we have *Mentha*, *Lycopus*, a single *Cunila*, *Pycnanthemum* (the whole seventeen species), an anomalous Satureia (S. rigida, *Bartr.*), three species of *Micromeria;* while to *Calamintha* is now referred the former M. glabella and M. Nuttallii, as well as the Gardoquia Hookeri, *Benth.*, with the new C. canescens, *Torr. and Gr. MSS.*, and C. Caroliniana, *Sweet* (Thymus, *Michx.*): also two species of *Dicerandra* (of which D. densiflora is a new one from Florida); the Californian *Pogogyne; Hedeoma*, including H. ciliata (Keithia ciliata, *Benth.*, *Lab.*); and *Collinsonia*, of which six species are recognized.

Of the tribe *Monardeæ* we possess a small portion of the vast genus *Salvia*, which is increased to four hundred and seven species; *Audibertia* of California, of six species; *Monarda* of six species (M. didyma and M. fistulosa being retained nearly as in the earlier monograph); and *Blephilia*, of two species.

The tribe *Nepeteæ* affords us *Lophanthus*; a single *Dracocephalum*; and a *Cedronella*.

The tribe *Stachydeæ* furnishes *Prunella*, for which Alph. De Candolle restores, with satisfactory reasons given, the orthography, *Brunella*; *Scutellaria*, of eighty-six species, sixteen of them N. American; *Physostegia*, of which two species are admitted; *Brazoria*, *Engelm.—Gray* (in which the synonyme "Physostegia truncata, *Hook. Bot. Mag.*, t. 3494," should be cited under B. scutellarioides, as shown in *Chlor. Bor.-Amer.*, and not under B. truncata); *Macbridea* and *Synandra*, each of a single species; and *Stachys* (from which *Betonica* is now excluded) of one hundred and sixty-eight species.

The tribe *Prasiæ* belongs entirely to the old world and to the Sandwich Islands; and the tribe *Prostantheræ* is exclusively Australian.

Of the *Ajugeæ* we have *Isanthus*; *Trichostemma* (in which a corrected view is taken of the inflorescence of the typical section); and *Teucrium*.

The small order, *Selaginaceæ*, contributed by Prof. Choisy of Geneva, consists of eight almost exclusively South African genera, to which the sub-arctic genus *Gymnandra* is doubtfully appended. Of three Siberian species of this genus two are found on our northwest coast, two are Himalayan, and one has recently been found by Aucher-Eloy in the mountains of Armenia.

The order *Stilbaceæ*, prepared by Prof. Alph. De Candolle himself, consists of three genera each of a single known species, and of one with five species; all of them natives of the Cape of Good Hope.

The *Globulariaceæ*, by the same author, comprises the typical genus, with eight species, and a new one of a single species; all of European and of Eastern Asia, except one in the Canary Islands.

The order *Brunoniaceæ*, also by De Candolle, contains a single genus of two Australian species; both made known by the prince of botanists whose name they bear.

Mr. Boissier, the most active and promising botanist of the Genevan school, has elaborated the *Plumbaginaceæ*. The tribe *Staticeæ* comprises six genera, viz., *Ægialitis*, R. Br., of the shores of eastern tropical Asia and Australia; *Acantholimon*, Boiss., of forty-two Central Asian species, and *Goniolimon*, Boiss., of seven North Asian species,—both distinguished from the following by their capitate, instead of filiform, stigmas; *Statice* itself, reaching to one hundred and ten species; *Armeria*, with fifty-two species, and *Limoniastrum*, of two Mediterranean species. The Statice of our own coast, S. Caroliniana, *Walt.*, Mr. Boissier distinguishes from S. Limonium by its fistulous scape, stricter branches, pyramidal instead of corymbose panicle, the distant one-flowered spikelets, and the very acute calyx-lobes; the Californian plant he introduces as a new species. The tribe *Plumbageæ* consists of the Siberian *Plumbagella*; the European and tropical

Plumbago; the Abyssinian *Valoradia;* and the African and North Indian *Vogelia.*

In the Corrigenda to the volume, we notice that Bentham has corrected the orthography of Trichostemma, so printed in the *Genera* of Linnæus, and by mistake in the *Labiatarum Gen. et Sp.* to *Trichostema*, as written by Gronovius, by Linnæus in the *Hortus Cliffortianus*, and as the derivation requires.

The *second part* of the thirteenth volume, to contain the *Phytolaccaceæ*, *Salsolaceæ*, *Basellaceæ* and *Amaranthaceæ*, by Moquin Tandon, is promised for April next. The *first part* of the same volume, devoted to the *Solanaceæ* and *Plantaginaceæ*, it is discreetly said, will be published later. The vigorous progress of this great work, however, in spite of the overturnings and confusion of continental Europe, at present so disastrous to science, is very gratifying. A. Gr.

2. *Annals of the Lyceum of Natural History of New York*, vol. iv, No. 12, September, 1848.

Wm. L. Jones, M.D.: Description of a New Species of Woodpecker —*Picus LeContei.*—p. 490, with a plate.

J. H. Redfield: Description of New Species of Bullia and Marginela, with Notes upon the Monograph, by G. B. Sowerby, Jr., of the latter genus: p. 491, with a plate.

O. W. Morris: Observations on the quantity of rain at different heights: p. 496.

O. W. Morris: Observations on the state of the weather before and after Auroras and Halos—On the quantity of rain at different elevations, with other Meteorological results: p. 500.

J. F. Holton: On Musical Intonation and Temperament: p. 504.

This number closes volume iv, of the Annals.

The following are the officers of the Lyceum for 1848–49:—

President, Joseph Delafield.—*Vice Presidents*, John Le Conte, Wm. C. Redfield.—*Corresponding Secretary*, John H. Redfield.—*Recording Secretary*, Robert H. Browne.—*Treasurer*, Charles M. Wheatley.—*Librarian*, Robert H. Browne.—*Curators*, B. W. Budd, M.D., J. G. Bell, R. H. Browne, J. C. Brevoort, W. Gibbs, M.D.

Report of Prof. Alexander D. Bache, Superintendant of the Coast Survey, shewing the progress of that work for the year ending October, 1848.—The Survey of the Coast is making good progress under the able superintendence of Prof. Bache. He observes that "during the past year the work has been carried into every State, with one exception, on the Atlantic and gulf of Mexico, and parties are on the way and under orders for the Pacific coast. The operations have been in progress on the full scale in four sections of the coast, including the reduction of the results; work of verification and filling up, and the engraving of charts from the back work, has been continued in the fifth section; the second stage of progress has been reached in a sixth and seventh section, and preliminary reconnaissance has been made in an eighth. The work has been equivalent, at least, to full activity in six sections. The estimates for the next fiscal year will furnish work equivalent to the full scale of operations in seven sections. A base line has been measured in one section, and two preliminary measurements of others made. Six sheets of charts have been published, and ten others are in the hands of the engravers. Thirteen sheets of maps and charts have been drawn in whole or in part within the year, exclusive of assemblage maps, sketches, &c."

Chemical Reports and Memoirs: Works of the Cavendish Society, founded in 1846.—Contains the following memoirs.—Prof. Otto, on the relation of the volumes of bodies in the solid state to their equivalents or atomic weights.

—M. Filhol, on the Connection between the Atomic weights, Crystalline form and density of bodies.—J. Vogel, on Endosmosis.—Prof. Otto, on Isomorphism. —M. Chevreul, on Dyeing.—M. Regnault, on the latent heat of Steam at different pressures.—E. Kop, on the Artificial formation of Alkaloids.—Prof. Bunsen, on the intimate Connection between the pseudo-volcanic phenomena of Iceland.

Henri Lecoq: Des Glaciers et des Climats, ou des Causes atmosphériques en geologie; in 8vo, 566 pp. *Paris*, 1847.

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L'Abbé D. Dupuy: Histoire Naturelle des Mollusques, terrestres et d'eau douce, qui vivent en France. 2e fasc. 10*fr.*

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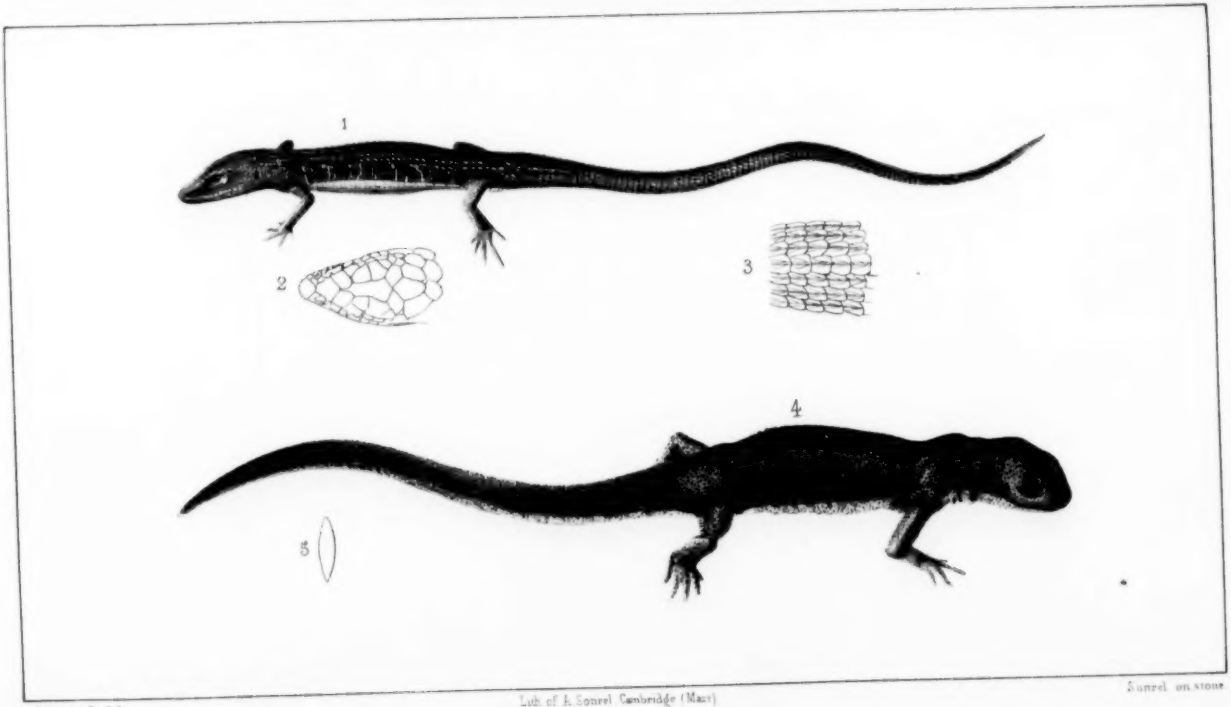
A. Guyot: Sur la Topographie des Alpes Pennines et le gite primitif des principales espèces de Roches qui se trouvent à l'etat erratique dans le Bassin du Rhone, (Extr. du Bull. de la Soc. Sci. Nat. de Neuchâtel, 1847.) 16 pp. 8vo. 1847.

A. Guyot: Sur la Distribution des espèces de Roches dans le Bassin Erratique du Rhone, (Extr. du Bull. etc. Neuchâtel) 32 pp. 8vo. 1847.

Annales des Sciences Naturelles, Paris, JUNE, 1848.—On Coral Zoophytes; Milne Edwards and J. Haime (continued.)—On the Osmylus maculatus; *L. Dufour.*—New Crustacean of the genus Macrophthalmus; *Milne Edwards.*—Circulation in Insects; *E. Blanchard.*—On an Amphipodous Crustacean; *M. Edwards.*—New Plants.—15th notice of the Cryptogamous plants of France, *J. B. H. J. Desmazières.*—On the spontaneous phosphorescence of the Agaricus olearius, *D. C.*; Rhizomorpha subterranea, *Pers.*, and the dead leaves of the oak; *L. R. Tulasne.*—Relations between the arrangement of leaves, the form of the vegetable axes and the pith; *L. Cagnat.*—Botanical prize, decreed by the Société de Phys. et de Hist. Nat. de Genève.



S. Emmons Jr. del

Lith. of A. Sonrel Cambridge (Mass.)

Sonrel on stone

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